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# THE IMPORTANCE OF ECOLOGY IN RELATION TO DISEASE[1]

By PROFESSOR RICHARD P. STRONG

DEPARTMENT OF TROPICAL MEDICINE, HARVARD MEDICAL SCHOOL

THE scientific study of the mutual relationship between organisms and their environment in regard to pathological processes is obviously a subject of great complexity, and one which may be discussed from many different standpoints. The importance of geographical ecology and of phyto-ecology is apparent in many investigations of this character, for the geographic, the climatic and meteorologic conditions influence the flora, and all these in turn affect the fauna; while both vertebrate and invertebrate animals may act as the intermediate hosts of the disease concerned. Indeed, so closely are animal and vegetable forms of life limited by physical barriers and environment that it has been proposed to classify climate according to prevalent species.

Again, ecological studies with reference to disease may often require a consideration of the reaction of the organism to environment—physiological or pathological ecology. In the development of parasitism, a transition in the life cycle of an organism may convert a physiological or harmless process into a pathological one.

In regard to the effect of climatic environment upon the human host, it may be recalled that even in the Middle Ages health and disease were firmly believed to be subject to cosmo-meteorologic influences. Soothsayers or authors of this period attributed epidemics of infectious diseases especially to atmospheric and to terrestrial phenomena, such as earthquakes, volcanic eruptions, severe storms or droughts, and even to the

[1] The Maiben Lecture before the American Association for the Advancement of Science, given at Minneapolis on June 25, 1935. (Illustrated with lantern-slides and moving pictures.)

appearance of meteors and comets. More recently sanitarians looked to the great variations in atmospheric moisture and temperature as favoring outbreaks of disease, to miasmatic influences, especially in malaria; and the rise and fall of water in subsoil, Von Pettenkofer's theory, in relation to cholera. So firmly did Pettenkofer believe in his theory that he later swallowed a culture of the cholera microorganism which Koch had meanwhile discovered, but he suffered from a mild attack of the disease.

So, etiological and ecological studies, which have revealed in many instances the cause and method of transmission of different infectious parasitic diseases, soon dispelled the majority of these fantastic or dogmatic ideas, or explained their influence in a more rational way or upon a scientific basis. Such discoveries have become not only of inestimable value in the introduction of intelligent public health campaigns against these diseases, but in a number of instances have revolutionized sanitary procedures which before had been erroneously regarded as valuable. Noteworthy examples of these facts have been seen in the prevention and eradication of yellow fever and malaria.

To-day, therefore, many of the biological processes which were formerly empirically attributed to climatic influences—the effect of the sun, the atmosphere and the surface of the earth upon the production of diseases in man--may be explained by the influence which environment exerts in furnishing unsanitary conditions, and especially, the parasites which cause and the insects which transmit infectious disease.

Thus true climatic diseases are exceedingly few. Examples which may be cited that are familiar to you are sunstroke, snow-blindness and frostbite. However, it is as a predisposing agent to disease that climate plays a most important rôle, and the resistance of the host is often profoundly altered by physical environment. Individuals are rendered more susceptible to a number of diseases by chilling and cold, and bronchial and other respiratory and lung affections, as pneumonia, are more common in winter than in summer.

On the other hand, a tropical, moist, monotonous climate may weaken resistance against infections, not because it disturbs metabolism, as has been emphasized by some, but on account of its failure to stimulate sufficiently the thyroid, adrenal apparatus and the sympathetic system.

Climate also plays a rôle in other physiological and pathological processes. The effect of sunlight, high temperature and humidity upon the central nervous system, the endocrine system and the metabolism have all been recognized. Also, there are many subtle effects of tropical sunlight and climate upon the white man which are not understood. Unquestionable is it that prolonged life in such a climate exerts a depressing influence which results in a more or less constant lassitude and tends to lower the vitality and energy.

Climate may influence the prevalence of another form of disease—avitaminosis, in quite another way, with reference to flora. For example, in the tropical countries of the world where rice is produced in such large quantities and hence consumed in its "polished" form in such abundance particularly because of its cheapness, in such countries, beriberi prevails.

In addition to these effects of the immediate environment upon the human host, ecological studies must often consider its effects upon the intermediate hosts in instances where they exist. Here, also, climate plays an important rôle, not only in the character of the vertebrate fauna which the region harbors, but especially of the invertebrate fauna. Also, at temperatures below a certain degree the parasites in the insects which transmit them may be unable to multiply or the insects satisfactorily to breed or even exist, as, for example, the parasites and insects concerned in the transmission of sleeping sickness and of malaria.

Ecological studies must also sometimes include the effect of environment upon the infecting organism, both that of the *milieu extérieur* and of the *milieu intérieur*. In regard to the former, the effect of meteorological conditions, especially the rainy season in the tropics, is often of great importance with reference to the spread of a number of tropical diseases, especially cholera and dysentery, and low temperatures and a low water deficit favor the spread of respiratory diseases, as pneumonic plague. In regard to the *milieu intérieur,* the invading microorganism in one individual may give rise to a fatal infectious disease, while in another individual, protected through his natural or acquired immunity, this identical microorganism produces no visible, or only slight, pathological effect. In the case where a natural immunity exists, the invading microorganism may remain in the individual as a harmless commensal.

Examples of this nature are seen in individuals with diphtheria bacilli (*Bacillus diphtheriae*) or with pneumococci (*Diplococcus pneumoniae*) in their throats who have never had either diphtheria or pneumonia. In some instances, when through cold, producing circulatory disturbances, inflammatory conditions of the respiratory tract occur, especially the *Diplococcus pneumoniae* may assume an increased activity. Under these changed environmental conditions the resistance or the protective mechanism of the patient may become lowered or the infective power of the microorganism enhanced—the microorganism acquiring what has been termed an increased virulence. Under such circumstances the microorganism may now invade more exten-

sively the tissues, and especially the lungs, giving rise to an attack of pneumonia which may result fatally.

In other instances in which active immunity has been acquired by the host, the invading microorganism, even when fully virulent, is not permitted to multiply even as a commensal in its host, but is destroyed at the time of its entrance or very shortly afterwards. This phenomenon may be illustrated in the laboratory by a convincing experiment. A guinea pig is inoculated intraperitoneally with a small amount (some 4 milligrams) of a killed culture of the organism of Asiatic cholera (*Spirillum cholerae*). A week later the animal may be inoculated with ten times the fatal dose, for it, of living cholera organisms, yet the animal remains apparently healthy, no unfavorable symptoms in it being noted. As a result of the primary inoculation with the killed bacteria, the blood serum of the guinea pig has acquired properties which permit it to destroy by bacteriolysis the cholera spirillum as soon as this bacterium is brought into contact with it. This experiment can be repeated many times invariably with the same result. Here a changed environment has been produced by active immunization of the host (through protective inoculation), which is inimical to the life of the invading organism.

Especially in relation to many of the most important diseases in tropical countries have ecological studies given us invaluable information regarding their origin and prevention, and in a number of instances a newly recognized environmental feature has cleared up problems which hitherto were entirely obscure.

On account of the intricate and comprehensive nature of the subject, I shall only attempt in the time at my disposal this evening to emphasize a few of the very apparent and striking ecological relationships regarding several of these diseases which I have particularly studied from this standpoint, but I shall not be able to consider all the environmental influences even in relation to these few diseases. Also, as this audience is composed of specialists in different branches of science, as well as of the laity, I shall discuss particularly such examples as I can illustrate pictorially.

You will probably recall that in the early and Middle Ages, in fact frequently during the first twelve centuries A. D., Europe was afflicted with severe epidemics of plague, in which the lymphatic glands were especially involved and inflamed, forming buboes, hence the name bubonic plague. But in the fourteenth century (1347) a form of the disease appeared of much more virulent type, known as the Black Death, and especially characterized by hemorrhages from the lungs—pneumonic plague. This disease destroyed, according to the estimate of contemporary writers, at least one fourth of the population of Europe.

The virulence, rapid spread and mortality of the epidemic of the Black Death was in great probability due to the pneumonic and septicemic form which the disease assumed.[2] The historical data of the period, the subsequent history of plague and the experience of the writer in the study of plague, in epidemics in different parts of the world since 1900, are in favor of this view.

The bubonic form of plague evidently was also present during this pandemic, but, as Guy de Chauliac emphasizes, it was the form attended by coughing of blood that was invariably fatal in three days, and this form was so severe and so contagious that it was contracted merely by being in the presence of the infected. However, history does not ascribe any reason acceptable to-day for the origin of this remarkable epidemic.

Coming to modern times, we know that bubonic plague still prevails in many parts of the world, especially in tropical countries, at times in epidemic form, as in India, and still gives rise to a very high morbidity and mortality. We know now that this disease is primarily an infection of rodents and that the microorganism causing it (*Bacillus pestis*) is transmitted from rat to man through the agency of the rat flea, *Xenopsylla cheopis;* the infection usually occurring by the entry through the skin of the plague bacilli, either regurgitated from the esophagus or discharged from the intestine of the flea into the wound made by the insect in biting to secure nourishment, or by scratching.

After the great outbreak of pneumonic plague in the fourteenth century, the disease disappeared in epidemic form and no extensive epidemic of it again occurred until six centuries later, in 1910 and 1911. Then, as history at times seems strangely to repeat itself, it broke out suddenly and apparently with most of its old fury or virulence in Manchuria and North China, and these countries were ravaged for three months in midwinter by an epidemic which in modern times has known no parallel either in magnitude or in the character and severity of the infection. Some of the episodes in this epidemic recall the horrors of the Black Death in the Middle Ages, for large numbers of the people of the Manchurian towns fled for their lives from the infected regions and their homes, leaving the sick to die unattended. Shops and factories were abandoned, trade and commerce came to a full stop. Dead bodies lay unburied in the houses, streets and fields, in some cases being partially devoured by dogs or by wolves and vultures. When help arrived the ground was frozen so hard to some depth that burial of the dead bodies in the ground was often impracticable, since temperatures of from 20 to 30

[2] These facts were emphasized by the writer in the Lowell Lectures upon "The Plagues of Man," delivered in Boston, 1916.

degrees below zero frequently prevailed. Finally, when the number of corpses became very large, wholesale cremation was resorted to, in spite of the protestations of the Chinese who hold the dead body sacred. Every person afflicted with the disease died of it. Nevertheless, in spite of many difficulties, this outbreak was carefully studied in this new environment, its nature and origin ascertained, and what is more important, the methods to prevent it were developed.[3]

Thus it was shown that while the germ of primary pneumonic plague is essentially the same as the organism of bubonic plague (with the exception of exhibiting a uniformly great virulence throughout the epidemic), the portal of entry of the microorganism is different from that in bubonic plague; and that in an epidemic of primary pneumonic plague, rats and fleas play no part in the transmission of the disease, the infection occurring directly from man to man by the droplet method of infection in a somewhat similar manner as in influenza. Overcrowding of the inhabitants in midwinter in small huts (sometimes thirty to forty people in one room) with very little ventilation was an important factor in the spread of the disease in Manchuria.

In the prevention of bubonic plague, for the reasons I have already given, the public health campaign must center upon the location of cases of the disease and the destruction of rats and fleas in infected areas; but in the prevention of epidemic pneumonic plague the public health campaign must center upon the early detection and isolation of cases and of contacts, evacuation of infected areas and masking. Individual masking in this disease is perhaps more effective than in protection against influenza, on account of the great difference in size of the etiological factors involved. In influenza, the virus, being ultra-microscopic, would probably not be interrupted to the same extent by the mask as the plague bacillus.

In the spread of respiratory diseases, the recent investigations of Wells and Stone (1934)[4] upon airborne infections are of interest, in which they point out the importance of dried infected droplet nuclei derived from droplets less than one tenth of a millimeter in diameter.

The influence of the environmental temperature is also of importance in the spread of respiratory diseases. Teague,[5] in connection with our Manchurian studies, especially emphasized that atmospheric temperature is an important factor in determining the spread, or failure to spread, of pneumonic plague. With Barber it was also pointed out that fine droplets containing plague bacilli remained longer in an atmosphere with a very small water deficit, such an atmosphere under ordinary circumstances being of common occurrence in very cold climates, as Manchuria in winter, whereas it is extremely rare in warm ones.

The writer found in Manchuria that the plague bacillus will remain not only viable but fully virulent after weeks in frozen sputum or in frozen corpses. When such sputum becomes frozen and pulverized it may be blown about and remain infective for considerably longer periods of time than when in the form of moist droplets. Isolated or small groups of cases of pneumonic plague (more commonly of pneumonic plague secondary to bubonic) have since the Manchurian epidemic occurred in various parts of the world, generally in tropical but sometimes in temperate climates. However, under the environmental conditions where these outbreaks occurred, the disease has not assumed epidemic proportions. One of the most important of these occurred in California in the winter of 1924. The first case in the outbreak was of bubonic character. Subsequently, thirty-two cases of pneumonic plague developed rapidly from contact, all terminating fatally. The immediate sanitary measures undertaken by the efficient health authorities prevented the further spread of the disease. The conditions in winter in Manchuria which can not be described in detail here still greatly favor outbreaks of primary pneumonic plague. Since the great epidemic there in 1910–11 the Chinese have had an efficient plague prevention service there under the direction of Dr. Wu Tien Teh. Last week Dr. Wu wrote me this work had been taken over by the Japanese.

We have spoken previously of the importance of environment upon the infecting microorganisms within the host. Such effect upon *B. pestis* is well shown in these two forms of plague—bubonic and pneumonic. In bubonic plague the organism entering through the skin at first becomes localized especially in the lymphatic glands, and these frequently may be said to act as filters against the general invasion of the host by the plague bacillus; often until an immunity is gradually produced in the host. However, in primary pneumonic plague there is no such mechanism for the defense of the host. The bacilli which have entered through the respiratory tract invade the circulation in every instance in a comparatively short time, and apparently before the host has had time to produce any appreciable quantity of immune substances. The plague organism also finds in the pulmonary tissues a much more favorable medium for its multiplication and its diffusion than it does in the lymphatic glands. Confirmatory evidence of these facts is seen in the

[3] Strong and Teague, Report of the International Plague Conference, held at Mukden in April, 1911. Manila, 1912.

[4] W. F. Wells and W. R. Stone, *Amer. Jour. Hygiene*, xx: 611 and 619, 1934.

[5] O. Teague, *Philippine Jour. Sci.*, Sect. B, viii: 241, 1913.

fact that the mortality in different bubonic plague epidemics varies from 30 per cent. to about 75 per cent., but the mortality in the Mukden epidemic of primary pneumonic plague was 100 per cent. From a consideration of these facts the importance of ecological influences in the production of these two types of disease, pneumonic and bubonic plague, must be apparent.

A second striking example of the importance of environment with reference to infectious disease occurred during the world war. In the Middle Ages epidemics of an affection known as sweating sickness, Piccardy sweat or as miliary fever were also common in northern Europe, especially in Flanders. Two forms of the disease were described—one very virulent, in which death usually occurred; the other much milder in type. In the first form were probably included many cases of typhus fever, influenza and probably meningitis. The severe form of sweating sickness had apparently disappeared entirely from Europe by the latter part of the nineteenth century, but the reasons for its disappearance are not evident.

During the world war a perhaps somewhat analogous disease to miliary fever was again encountered, particularly on the western front to which the term trench fever or Volhynia fever was applied, and in which severe sweating was often a striking symptom, as was pointed out by Swift and others. Trench fever caused a greater morbidity in the British army during the war than any other disease.

The question naturally arose as to why this sudden and extensive outbreak of trench fever occurred. It should be recalled that many of the troops in the trenches, dugouts and billets were crowded at times and they lived under conditions which simulated in some respects those in the Middle Ages. They were often exposed to rats, their clothing was not frequently changed and washed, they did not bathe frequently and they became very lousy. We were able to prove by 103 experiments made in a tent hospital in Flanders upon human beings—volunteers from our army—that the organism causing this disease is present in the blood serum of infected individuals and that the disease is transmitted from man to man by the body louse *Pediculus humanus*.[6] A British commission (Sir David Bruce, Byam and Bacot), working upon cases of trench fever imported into England, also conclusively demonstrated this fact. Hence it seems evident that it was especially because of the unhygienic environment of the troops, overcrowding and filth, that this disease recurred and prevailed to such an extent on the western front, for since the war, it has almost disappeared. Only an occasional case has subsequently been reported among the poor in parts of Russia.[7] Perhaps this virus is still kept alive in rats and pediculi.

In the great European epidemics of typhus fever, and especially in the epidemic of typhus in Serbia in 1915, the most virulent in modern times with the possible exception of the recent Russian one that exceeded it in magnitude, we have had important epidemiological evidence of the fact that the disease is transmitted from man to man by the body louse, *Pediculus humanus,* as was first demonstrated by Nicolle in 1910, and the favorable effect of delousing in the prevention and eradication of the disease in Serbia was especially demonstrated.

Under a different environment in this country and in Mexico, and more recently elsewhere in Europe, in South America and in the Far East, much milder forms of typhus are encountered. The form which occurs in this country is known especially as Brill's disease or as mild sporadic typhus. The investigations of Zinsser, Castaneda, Mooser (1931), of Rumreich and of Dyer (1931) and of Maxcy (1928) give evidence to the effect that the rat may serve as the reservoir for this type of virus and that man may acquire infection not only directly from man to man through the louse, but from the rat flea, especially *Xenopsylla cheopis.* Here again the influence of environment upon these two forms of typhus virus is emphasized.

Obviously we refer here not only to the influence of geographical environment alone, but also to that environment furnished by different intermediate hosts in different regions, by the immunity of the human host, modified by racial qualities, by habits and customs of the people which bring the individual into contact with the source of the infection. Thus in different parts of the world we find evidence of changes in the insect-animal cycle of transmission of these typhus viruses, for example in the Far East in Tsutsugamushi disease by mites to field mice or rats, or in Montana in Rocky Mountain spotted fever by ticks (Wolbach, 1919).[8] Zinsser (1935)[9] has recently discussed the subject from many different standpoints, which include the subjects of latent infection and immunity, but he has pointed out that there is still an element of speculation in the explanation and that opinions are not entirely unanimous.

Onchocerciasis is another disease the occurrence and character of which are especially influenced by environment. It is characterized by the presence of subcutaneous fibroid nodules or tumors, varying in size from 2 to 3 millimeters up to 5 or 6 centimeters

[6] "Report on Trench Fever." American Commission, 1918.

[7] P. I. Braslawsky, *Munch. Med. Wochenschr.*, lxxxi, 172, 1934.

[8] S. B. Wolbach, *Jour. Med. Research*, 1919, 1, xli.

[9] H. Zinsser, "Rats, Lice, and History," Boston, 1935.

in diameter. The location of these nodules or tumors and their number vary greatly in different individuals and in different parts of the world. Thus in Guatemala and southern Mexico they are found in the great majority of cases in the region of the head, especially about the scalp, comparatively few upon the trunk. In number they usually vary from 1 or 2 up to 5 or 6, though rarely even more nodules may be present. But in parts of Africa, as in Sierra Leone, Liberia and some districts in the Belgian Congo, the tumors are usually found upon the trunk, especially in the intercostal spaces or in the region of joints, rarely on the head. Usually only 1 or 2, but sometimes more, have been observed.

On the other hand, in the Province of Lusambo, Central Africa, one may find nodules very commonly present on the scalp, over the shoulders and trunk. In a great many individuals in this region there are numerous small nodules scattered over the head, shoulders and trunk, varying in number from several up to 150 or sometimes even more.

These nodules are of parasitic origin. The adult parasites, both males and females, of the species *Onchocerca volvulus* or *caecutiens,* are found in the central portion of the nodules in which there are often cavities or softened areas. Immediately about the adult parasites there are usually more or less evidences of an inflammatory process. The outer portions of the nodules are composed largely of fibrous connective tissue in which the fibroblasts are few in number, and the fibroglia fibrils not abundant. In many instances the greater part of the tumor is composed of collagen fibers forming wavy bundles. The adult male and female parasite mate in the tumor and the female gives birth probably daily to an enormous number of microfilariae, which may measure from 150 $\mu$ (at the time of their birth) up to 350 $\mu$ in length. These circulate, not in the blood, but in the lymph spaces, and apparently show a tendency to seek the light. They are found usually in the upper portion of the corium of the skin and the tissues of the eye, particularly in the conjunctiva, iris and cornea. The adult parasites are evidently the inciting factor of the nodules which are formed about them. The enormous number of microfilariae circulating in the skin and tissues of the eye give rise to inflammatory changes in many individuals that possess an especial susceptibility to the products of metabolism and to the presence and movements of the parasites. Thus in the skin, isolated or confluent, pruriginous areas may occur, and the inflammatory process be further increased by scratching. In such areas sections of the skin usually show numerous microfilariae in the corium, with perivascular proliferation and infiltration of the corium, with lymphocytes, polymorphonuclear leukocytes or plasma cells. The eosinophils of the blood are usually increased, counts of from 25 to 50 per cent. being usual.

In cases of long standing in which there is severe infection with microfilariae, a xerodermatous condition of the skin may be produced. Sections of such skin, in addition to the large numbers of the parasites, show more or less extensive cellular infiltration in the corium. In some areas the sebaceous and sweat glands are few or absent, and changes in the thickness of the horny layer in the skin may occur.

In the eyes the lesions particularly consist of a pericorneal conjunctivitis, iritis and keratitis, which not infrequently lead to loss of sight.

Histologically one finds in such eyes extensive infiltration of the tissues with microfilariae, accompanied by perivascular proliferation, and infiltration with endothelial cells. Small groups of lymphocytes, polymorphonuclear leukocytes and plasma cells are frequently seen. In more advanced cases vascularization of the cornea may occur, and a proliferation of fibroblasts. Infiltration and destruction of Bowman's membrane and even of Descemet's membrane sometimes occurs. Apparently it is the continual presence and passage of large numbers of microfilariae through the tissues of the eye and especially through the compact cornea that give rise to the inflammatory processes. It also appears probable that the microfilariae, through their metabolism or death and destruction in the tissues of the eye, may exert a pathological effect. The circulatory disturbances in these tissues may also predispose to secondary bacterial infections.

The disease is transmitted by the bites of several species of small black flies of the genus *Simulium,* and this fly is found breeding in the rather swiftly flowing streams or brooks that abound in the infected districts, the larvae and pupae of the flies being attached particularly to the leaves and stems of plants, especially floating grasses growing or immersed in the running water, as well as to the surfaces of stones.

It is especially through ecological studies that our knowledge of this disease and its control has been advanced. Thus it has been shown that the prevalence and spread of the infection are especially dependent upon the geographical, climatic and botanical conditions which are favorable for the breeding and life of the fly which transmits the infection.

The agricultural pursuits of the inhabitants evidently are also of importance in connection with the dissemination of the infection. In Guatemala and southern Mexico, the disease is only found upon the Pacific or southern slopes of the volcanic ranges, at altitudes between about 2,000 to 4,500 feet. It does not occur at lower altitudes in Guatemala, and it is especially connected with the coffee production, the best coffee being produced in these regions and at these

altitudes. It is in connection with the production of coffee that the inhabitants are especially brought into contact with the fly that transmits the disease. In Guatemala, in the different coffee plantations in which we worked, we found from 40 to 66 per cent. of the inhabitants infected.

Onchocerciasis does not exist endemically in Guatemala and Mexico at altitudes below 2,000 feet, because the species of *Simulium* fly which transmit the disease there, *S. avidum* (syn. *metallicum*), *S. ochraceum* and *S. mooseri*, do not breed below that altitude. Nevertheless, in certain coffee-producing districts in which the altitude and climatic conditions correspond to those of districts in which the disease is endemic, and in which these three species of *Simulium* abound, and the inhabitants are similar, onchocerciasis is not found. This emphasizes the fact that human beings infected with the disease constitute the most important focus of infection.

In the Province of Lusambo, in Africa, where onchocerciasis is prevalent to an even greater extent than in Guatemala, there is no coffee production. Here the production of cotton is one factor which predisposes to infection, and it is the agricultural pursuit which especially brings the inhabitants into contact with *Simulium* flies. Prior to 1910 there was no cotton exported from the Belgian Congo, but since 1915 the amount has steadily increased, and in 1930 over 10,000 tons were exported.

In Africa, *Simulium damnosum* is the species of black fly which is particularly concerned in transmission of the disease. This fly is frequently found breeding at altitudes below 1,000 feet. Corresponding to this distribution of the fly, we find that onchocerciasis prevails very extensively at altitudes below 1,500 feet, as in Liberia, Sierra Leone and parts of the Belgian Congo, especially Lusambo and Katanga.

While the infected *Simulium* is the only means of the transmission of onchocerciasis from man to man in the endemic regions, owing to the habits of these flies they probably do not play an important rôle in spreading the infection to distant localities. The infected individual constitutes a more important means of transmission of the disease to distant localities than does the *Simulium*. From ecological studies carried out in different countries, we are able to explain in part the great variation in the number of nodules or tumors in different districts, as, for example, in Guatemala and Lusambo, or even in the same locality, on the basis of the different number of times that the individual has been bitten with infected flies. In Guatemala, where the number of nodules per infected person is not usually over 1 to 3 or 4, we never found in any district in which we worked more than 5 per cent. of the *Simulium* flies caught in the villages infected with the parasite, but in Lusambo, Bequaert, Sandground and the writer found as high as 33 1/3 per cent. of such flies infected. Cases in Lusambo with 20 to 50 *Onchocerca* nodules were not uncommon. Such individuals had been bitten probably by at least that number of infected flies, probably by more.* However, in some instances it seems extremely likely that a single fly may at one biting introduce several infective forms of the parasite. In some villages in Lusambo practically every inhabitant was found to be infected.

On the other hand, we are not yet able to give a satisfactory explanation of the location of the tumor upon different parts of the body. It has been suggested that the point at which the fly bites may be an important factor in determining the location of the tumor. We have been unable to find any convincing evidence of this fact. In Guatemala where the nodules occur so commonly upon the head, the flies were found very frequently biting upon the legs. This fact would not satisfactorily explain the absence of tumors on the lower extremities or trunk except in 2 per cent. of the cases, and the location of the tumor upon the head in 98 per cent. of the cases if the point of the fly bite determined the location of the tumor. We have no evidence demonstrating that the tumor forms in the vicinity of the point where the fly bites. Most of the tumors in Guatemala are upon the scalp, which is generally covered with coarse bushy hair, and most of the natives also wear hats during the daytime. Nothing is known of how far or how long a period of time the infective form of the parasite travels before it becomes surrounded by the cellular inflammatory exudate and embedded in the fibrous connective tissue, which is the first step in the production of the nodule. From the fact that the tumors often form on parts of the body where pressure for various reasons is likely to occur, it seems possible that the frequency of the nodules on the head in Guatemala may be influenced by the lymph vessels of the subcutaneous tissues of the head becoming constricted in some way by hats or head bands worn in the daytime, or by the head resting upon a hard pillow or some wooden object at night. It seems clear that in those individuals in which the tumors are located upon the head or shoulders, there are more likely to be disturbances in the eyes, and that in cases in which the tumor is located at considerable distances from the head, ocular lesions are usually not present. In this connection it has been conclusively demonstrated that the microfilariae are found in greatest number in the skin in the vicinity of the tumors, and that at considerable distances from the tumors very few or no microfilariae may be encountered. In Guatemala we found the microfilariae in the skin most abundant in that of the face; usually very

few or none in that over the ankles or feet. Whether or not the microfilariae are positively phototropic, it seems obvious that the tissues of the eye are localities in which they are especially encountered, and the microfilariae are much more numerous generally in the ocular conjunctivae in cases with nodules about the shoulders and head than in cases with nodules elsewhere on the body.

In connection with the study of the origin of the disease, in Africa, during our recent expedition, investigations were made by the writer (assisted by Sandground and Bennett) to see if another mammalian host besides man could be found for the parasite *Onchocerca volvulus*. With this object in view, an examination was made of every animal shot. Though game was not plentiful in the region where the studies were made, investigations upon small mammals and of various species of antelope (reedbuck, roan, harnessed antelope, sable and eland), of wart hog, buffalo and hippopotamus were carried out. A species of *Onchocerca* was found in *Bubalis cafer,* and a single specimen in one sable antelope, but this parasite does not give rise to nodules in the buffalo or in this antelope, being found especially in the ligamentum nuchae, and resembling both in this respect and in many of its morphological characteristics *Onchocerca reticulata* or *O. gutturosa,* which have been found especially in the horse and in cattle. However, in eland, in studies carried out by LaRue and the writer, subcutaneous nodules were found in which a species of *Onchocerca* was present, apparently identical morphologically with *O. volvulus*. Sections of these tumors reveal cross-sections of the adult parasites and a similar histological structure to that observed in other nodules caused by *Onchocerca volvulus.*

In northern Rhodesia the cattle show a high rate of onchocercal infection. Here two forms are observed, and these have been studied especially by LaRue and subsequently by the writer. In one, the cervical and shoulder ligaments are specially involved by the parasite; in the other form, subcutaneous nodules are present or nodules in the musculature.

*Onchocerca* nodules have also been found in the intercostal regions of cattle on the Gold Coast, and Cameron has found that the parasite in these nodules does not differ morphologically from *O. volvulus.*

It seems evident, then, that in onchocerciasis, as is the case in sleeping sickness, a species of antelope may sometimes act as a reservoir for the parasite, and that, especially in regions where eland has been domesticated, cattle might acquire infection from these infected antelope. It seems possible also that human infection may even originally have occurred from wild animals, and subsequently from cattle. In a pygmy village where *Simulium* was highly infected, the inhabitants were badly infected with onchocerciasis. Pygmies, as is well known, spend a large part of their lives in hunting wild game; they do not till the soil or have any agricultural pursuits. From evidence obtained by LaRue and the writer in northern Rhodesia, the infection in cattle seems to be in favor of transmission by *Culicoides* rather than by *Simulium,* as Steward has shown to be the case in *Onchocerca cervicalis* of the horse in England.

It may be that in onchocerciasis we have an example of an invasion of man by a parasite which before had been well established within the animal kingdom and that infection of man may have originally occurred through new contacts with infected animals and insects to which man was not previously or extensively exposed. Whether the origin of the disease in man in Guatemala may also be explained in this manner is not yet clear. Obviously the strains of *Onchocerca* which have now, both in Africa and in Guatemala, become thoroughly established in man are transmitted by *Simulium* entirely independent of other mammals.

Sleeping sickness of the form caused by *Trypanosoma gambiense* or *rhodesiense* probably represents another disease of this nature and one that is limited endemically to the territory in which the important insect host, the tsetse fly, exists (especially *Glossina palpalis* and *G. morsitans*). However, while onchocerciasis and *Simulium* may be present at altitudes over 3,000 feet, *Glossina* is seldom seen above 3,000 feet, and sleeping sickness does not originate in higher altitudes. Also, brush-clearing, especially along streams and rivers, is sometimes the only certain method of freeing an area from some species of the tsetse fly and of thus limiting the spread of the trypanosomiasis. However, while brush-clearing is very effective with reference to *G. palpalis* and *G. tachnoides,* it is not often effective against *G. morsitans,* as this species will often cross carefully prepared clearings over a mile in width. In such areas it is far more effective to remove the population when possible. Many ecological problems have been solved with reference to sleeping sickness.

The effects of climate upon *Glossina* have recently furnished epidemiological facts of importance. It has been shown that there is a fairly narrow zone of temperature within which the fly can live satisfactorily. Temperatures between 25° to 30° C. are very satisfactory for *G. morsitans,* but above 35° C. it very frequently dies. Buxton and Lewis (1934) found that at temperatures above 40° C. the *G. morsitans* and *G. tachnoides* flies, which may survive for short periods, are more apt to do so in dry air than in moist. However, the effects of humidity, while very important to *Glossina,* are also very complex. With a temperature

of 30° C., a relative humidity of about 44 per cent. appears to be near the optimum at which the flies live longer and breed more rapidly than in drier or in moister air. A relative humidity of 65 per cent. was unfavorable, and in moister air the flies nearly always refused to feed and were found to die off very rapidly. The reason why high humidities were unfavorable is still obscure. Flies were found to metabolize fat most rapidly in dry air, and presumably to produce metabolic water to compensate for excessive evaporation. In general it has been found that when the humidity is high, the *Glossina* are scarce and that the flies do not breed so well in such an atmosphere. Johnson and Lloyd found that in the rainy season (May to October) only 20 to 40 per cent. of female *Glossina tachnoides* were pregnant, but in the dry season (November to April) 60 to 80 per cent. were pregnant.

Jackson (1934) found that during the dry season in Tanganyika, *Glossina morsitans* increases in numbers in the drainage valleys as distinct from the bordering woodland. Observations by him and by Burtt support the contention that the increase of the fly in the drainage valleys in the hot dry months is due not to a search for better shade conditions, but to the fact that these areas constitute a feeding ground and that the fly must visit them more frequently at this season when the onset of hunger is hastened by hot dry conditions.

In certain areas where large numbers of cases of sleeping sickness are congregated, even where *Glossina* does not abound, infections may sometimes occur if other blood-sucking Diptera, as for example *Stomoxys*, are present. It is now well known that the trypanosomiasis of horses in the Philippines and elsewhere in the Far East caused by *Trypanosoma evansi* is usually transmitted by *Stomoxys* mechanically. Duke, during the past year, has moreover shown that *Trypanosoma rhodesiense* was readily transferred from an infected to a healthy monkey by the process of interrupted feeding of from 7 to 10 wild *Stomoxys,* and that infection from antelope to antelope might also occur by *Stomoxys*. However, transmission of trypanosomiasis by *Stomoxys* in man is probably relatively rare, as sleeping sickness has shown no tendency to spread extensively in areas where *Glossina* does not abound.

Many other ecological problems are involved with reference to sleeping sickness. Both the insect and mammalian environment exert influences upon the trypanosome which emphasize that pathological manifestations are only incidents in a developing parasitism. Thus in the blood stream of the mammalian host, the trypanosome may at least for a long period give rise to only slight or no pathological manifestations, but when it invades the central nervous system, serious disturbances are usually produced. It is now generally recognized that, although *T. rhodesiense* when first isolated from cases of sleeping sickness in man exhibits considerable resistance to the action of normal human serum, this resistance is sometimes largely lost after a series of mechanical transmissions through experimental animals. However, little work has yet been done on the influence of cyclical transmission of this quality. Adams found that cyclical transmission of *G. palpalis* caused diminished resistance to the action of the serum, whereas Lester observed that experimentally produced serum-fastness in *T. brucei* was transmitted by *G. tachnoides.*

The relationship of *T. gambiense* (or *T. rhodesiense*) to *T. brucei* is regarded by some investigators as still somewhat obscure. As is well known, the latter trypanosome is considered to be capable of not only causing the disease nagana in cattle, but also as sometimes living as a commensal in some domesticated animals or wild game. Experimental inoculations of man with the blood of horses and mules containing *T. brucei* have frequently resulted negatively, as Taute and Huber in 131 human experiments have shown.

Duke has recently examined the power of *Trypanosoma rhodesiense, T. gambiense* and *T. brucei* respectively to develop in *Glossina,* and has found that *T. rhodesiense* is as a general rule more readily transmitted by *Glossina palpalis* than is *Trypanosoma gambiense,* and this notwithstanding the fact that *Glossina palpalis* is not considered to be the normal vector of *T. rhodesiense.* Whether these characteristics will survive repeated cyclical passage through *Glossina palpalis* is, however, a matter which will require further investigation. Duke suggests that *T. rhodesiense* may in reality be *T. brucei,* which has overcome man's resistance. However, there is an alternative explanation, namely, that *T. rhodesiense* is *T. gambiense,* which has enjoyed a longer or shorter association with *Glossina morsitans* instead of *G. palpalis.*

Extraordinarily slight changes such as these in the mutual adjustment between parasite and host may profoundly alter clinical and epidemiological manifestations.

Other changes of this nature may be seen in the study of the power of transmissibility by *Glossina.* It has been found that *Glossina* may be incapable of transmitting some of these strains of trypanosomes, and the strains may even have become incapable of infecting the fly. Some strains of *T. brucei* have shown somewhat greater stability in the power to infect than *T. gambiense.* Such behavior may suggest an expression of a more perfect adjustment of environment than is possessed by *T. gambiense,* the latter trypanosome, which is essentially dependent on man, having not yet attained biological equilibrium in

this its principal mammalian host. Duke (1935) however, believes that it is established beyond all reasonable dispute that *T. rhodesiense* may lose power of infecting man as a result of living for a long time in the blood of antelopes. In the course of maintenance for a year or more away from man by cyclical passage from monkey to monkey, some strains of *T. rhodesiense* retain the power of infection of man, but others lose it.

On the other hand, Corson (1935) has found that a strain of *T. rhodesiense* can be maintained in sheep and goats for nearly two years without loss of its transmissibility by *Glossina morsitans* or its power to infect man. However, in other experiments he was unable to transmit *Trypanosome rhodesiense* from man to laboratory animals by the bites of *Glossina,* and had to resort to direct inoculation of the blood to succeed in infecting them. He has also shown that this strain of trypanosome could be passed from man by inoculation of the blood to a guinea pig, and then from this animal by four successive flies, through three antelope, and finally by another fly back to man. Thus with this strain of the trypanosome no change in the infective power for man of the trypanosome had occurred during the cyclical passages through guinea pig, antelope and fly. Such discrepancies suggested by these different experiments of Duke, Corson and others are not impossible to explain rationally. The writer has pointed out elsewhere (1930) that extensive investigation has shown that *T. rhodesiense* is indistinguishable morphologically from *T. brucei,* but that *T. rhodesiense* usually exhibits greater pathogenicity for man. However, different strains of *T. rhodesiense* may in some instances lose this power to infect man by passage through animals more or less susceptible, but in other instances retain it. Human beings differ in their resistance to strains of trypanosomes, as do other animals. Man is probably, by the natural mode of infection, immune to the trypanosomes of animals. It is perhaps only in those instances in which an individual especially susceptible becomes infected through a large number of virulent trypanosomes that the trypanosome becomes adapted to life in human blood, and then may more frequently infect other human beings. While it is probable that some virulent human strains of trypanosomes are capable of infecting the majority of human beings, animal strains, feebly pathogenic for man, will probably only infect at first abnormally susceptible individuals, though later, when such strains have become thoroughly established as parasites in man, epidemics of sleeping sickness may be caused by them. The differences in power of infecting of *Glossina* and of man and other animals of *T. gambiense, T. rhodesiense* and *T. brucei* may all be explained as changes which one species of trypanosome may undergo under different environment.

Quite another problem is suggested by the fact that sleeping sickness in certain parts of Africa has undergone rapid retrogression, sometimes spontaneously, without the cause of this being apparent. In some areas, where tsetse flies abound and game are fairly plentiful, there are no evidences of human infection. In other areas the infection has persisted and spread in spite of the introduction of treatment and of other preventive measures. It is difficult to understand why in some areas trypanosomiasis readily yields to treatment, while in others it is resistant to the same treatment. Differences of race, of habitat, of absence of *Glossina* and of virulence of the trypanosome probably exert some influence in these respects, but these factors do not entirely explain such results. Whether the failure to successfully treat many chronic cases of sleeping sickness is due to the development of arsenic-fast strains of trypanosomes which are now being propagated by *Glossina* in such areas, as suggested by Yorke, has not yet been demonstrated.

The relationship of wild game, especially of antelope, to human trypanosomiasis is still a controversial problem. Duke's recent experiments suggest that although some antelopes may be favorable hosts for *T. rhodesiense,* yet, as a reservoir from which tsetse flies can become infected with trypanosomes pathogenic for man, these animals do not constitute so great a menace as was hitherto supposed. Thus of six human beings (volunteers) exposed to twelve flies infected from antelopes (reedbuck) with *T. rhodesiense* that had been maintained in these animals for many months, only one volunteer became infected. A strain of *T. rhodesiense* after a survival of cyclical passage through a reedbuck and six monkeys was found to be non-pathogenic for man, although it was tested in nine different volunteers. Duke suggests that this strain owes its original association with man to meeting an abnormally susceptible individual. There was nothing to distinguish it from *T. brucei* except its isolation from man.

Corson has recently inoculated eight adult antelope, dik-dik and one duiker experimentally with *Trypanosoma rhodesiense.* In all these animals just before death, or just after death, trypanosomes were found in the cerebrospinal fluid. He remarks that it is hard to understand how these antelope can survive in sleeping sickness areas, where of course they are often present, unless exposure to tsetse fly bites and habituation to mild strains of *T. brucei* infection give them an acquired and selective resistance.

Epidemics of sleeping sickness in man have occurred in which game animals played no part in the spread of the disease, the trypanosome being carried

directly from man to man by the bite of the fly, frequently mechanically.

In connection with the wholesale destruction of game in parts of Africa, it should always be considered that if the game is so reduced that the tsetse flies of the *Glossina morsitans* group are driven to attack man for food, a much wider dissemination of these flies is likely to occur, and hence further spread of human trypanosomiasis may result. Several human outbreaks attributed to this influence have recently been recorded. In parts of Tanganyika a much wider dissemination of *Glossina* has recently occurred, and since the institution of the Masai Reserve in Kenya Colony the fly belts within its confines have extended their boundaries and increased in number. In the case of *Glossina swynnertoni* (a vector of human as well as of animal trypanosomiasis) Lewis (1934) has obtained evidence which shows that there has been an actual invasion of it from Tanganyika Territory. Swynnerton has shown that *G. swynnertoni,* in the presence of cattle but where game is scarce, attacks man readily. More recently Lewis has found that in the presence of an abundance of game and in the presence of cattle, this fly very readily approached man and was also attracted to moving vehicles. In view of all the facts the special merits of vegetational control of the disease become emphasized in which not only elimination of the favorable breeding places of the fly is attempted, but the character of the vegetation so altered that the fly no longer inhabits such regions.

The epidemic of malaria with its high mortality which has recently been raging in Ceylon, India, is a striking example of the effect that climatic conditions and environment may exert upon a disease. This epidemic has occurred in what has been hitherto regarded as the most healthy and prosperous portion of the island, the southwestern part, in which there has usually been a high annual rainfall and where there has been evidence that the percentage of the population infected with malarial parasites has been but small, and hence the population relatively non-immune to the disease. This year the prevailing rains which are brought so regularly by the southwest monsoon failed to supply the usual amount of water, resulting in a prolonged drought. Then came a few heavy rains, and then drought again. Thus conditions arose greatly favoring the breeding of the mosquito *Anopheles culicifacies,* which transmits the disease in this region, as many shallow pools were formed along the river beds and streams. Through these innumerable temporary breeding places, more perfect conditions for the production of mosquitoes could probably not have been devised.

The outbreak of malaria was followed by failure of the crops, also due particularly to the lack of rain. Thus the people became further impoverished and the general state of their health reduced, and within five months there were 113,811 deaths, of which 66,704 were estimated to be due to malaria.

Malaria only prevails in an unsanitary environment. During the year 1934 Dr. McKinley in a statistical survey found that over 54,000 cases of this disease had been recognized and reported in a few of our southern states, or 15,000 more cases of malaria in these regions than of tuberculosis. Other statistics show that the malaria mortality is over 20 in 13.5 of the counties, and over 50 in 3.03 of the counties in the southern United States. Malaria has been banished in this country from many localities where it formerly prevailed. It is a disease that we know can be eradicated by sanitary measures. In view of the enormous sums of money that have recently been appropriated by our Federal Government for conservation and reclamation, would it not be most appropriate and indeed a wise investment if at least a small fraction of this sum were devoted to the eradication of this dreadful disease from which so many of our citizens have already died and others still suffer and are thereby incapacitated for work?

Although in support of our subject many additional examples, particularly with reference to other infectious and parasitic diseases, might be discussed, the few which have been referred to in this lecture would appear to be ample for the purpose of emphasizing the importance of ecology in the study of disease—the importance of environment upon the vertebrate and invertebrate host and the infecting organism.

# OBITUARY

## CHARLES ELWOOD MENDENHALL

American science lost one of its ablest devotees and American scientists one of their most beloved leaders as Professor Charles Elwood Mendenhall passed away on August 18, after an illness of less than a year. News of his death came as a shock to his friends who, outside the intimate circle at the University of Wisconsin, had not realized the serious character of his illness. At the age of sixty-three, he was at the peak of his effectiveness as an inspiring teacher, able investigator and wise counselor.

Charles Mendenhall was the second generation of distinguished physicists. His father, T. C. Mendenhall, a Quaker, was the first professor appointed at

Ohio State University and, from 1878 to 1881, co-operated in the founding of the Imperial University of Japan. It was there, as a small boy, that Charles acquired his life-long love of Japanese art. T. C. and Charles Mendenhall were the third "father-and-son" group to be honored by election to the National Academy of Sciences. His mother, Susan Allen Marple, was of English birth.

Born on August 1, 1872, in Columbus, Ohio, Mendenhall graduated B.S. from Rose Polytechnic Institute in 1894 and received his Ph.D. degree in 1898 from Johns Hopkins, where he had the privilege of study under the great Professor Rowland. Prior to his postgraduate work he spent parts of two years as aid in the U. S. Coast Survey and was assistant in physics for one year at the University of Pennsylvania. His subsequent academic career consisted of three years as instructor in Williams College, from 1898 to 1901, followed by continued service at the University of Wisconsin, where he was an assistant professor from 1901 to 1904, associate professor from 1904 to 1905, professor since 1905 and chairman of the department of physics since 1926.

During this period, the University of Wisconsin became one of the great centers of physical research and inspiring graduate study. For many years, until the latter left to assume administrative duties at the University of Chicago and the Rockefeller Foundation, Charles Mendenhall in experimental physics and Max Mason in theoretical physics formed a notable team. Mendenhall's research interests were broad, so as to have earned him the reputation of being "one of the few remaining natural philosophers." His primary interests, however, were in surface characteristics of metals, and included, specifically, infra-red radiation from black bodies, luminous efficiencies and radiating constants of metals, and their photoelectric, thermionic and contact potential properties. His work was characterized by thoroughness, precision, insight and skill. He developed improved methods of measurement, notably improving galvanometers, bolometers and procedures for measuring high temperatures.

Being, by nature, generous and helpful, Mendenhall's creative genius found more and more expression in the work of his students and younger colleagues. Among the three dozen or more students who took their Ph.D. degrees under his immediate supervision, are a goodly number who have won national and international reputation and who now hold responsible positions in many institutions and organizations. It is through such men that his work in physics will continue, just as the truths which he discovered and the influence which he exerted constitute his permanent contribution to human welfare.

In addition to his academic work, Mendenhall has been one of the great influences in building up and making effective the leading scientific organizations in his field. He was president of the American Physical Society from 1923 to 1925 and vice-president of the American Association for the Advancement of Science and chairman of its Section B in 1929. As chairman of the Division of Physical Sciences of the National Research Council from 1919 to 1920, he was influential in effecting the transition from war-time to peace-time activities of that body. In particular, he was an invaluable member of the National Research Fellowship Board during practically its entire existence and, in this capacity, exerted a profound influence on the remarkable development of activity in the physical sciences in America in the last fifteen years. His other scientific society affiliations include the American Philosophical Society, the American Optical Society, the American Academy of Arts and Sciences and (mentioned above) the National Academy of Sciences, in which he served for several years as chairman of the Physics Division.

One of Mendenhall's notable public services was as major in the Signal Corps during the war. In this capacity, and jointly under the National Research Council, he played an important rôle in the organization of American scientists and laboratories for war service. He was particularly active in handling scientific devices and inventions for war purposes and in selecting scientific personnel for their development and use. During this period, 1917 to 1919, he resided in Washington. Immediately following the war, in 1919 and as successor to Dr. Henry A. Bumstead, he served for six months as scientific attaché to the American Embassy in London, at the same time acting as the London representative of the Research Information Service.

The intellectual distinction of the Mendenhalls has been continued in Charles Mendenhall's own family. In 1906 he married Dorothy M. Reed, an alumna of Smith College, of the Massachusetts Institute of Technology and of the Johns Hopkins Medical School and honorary D.Sc. from Smith College. Mrs. Mendenhall is a recognized authority on matters of diet and child health, has been a lecturer in the University of Chicago and elsewhere, and is a medical officer of the Children's Bureau in Washington. Their two sons are following similar intellectual lines: Thomas C. is a Rhodes scholar at Oxford and John T. is a medical student in Harvard University.

With his able devotion to his favorite field, physics, his love of art and music, his pleasure in such pastimes as fishing, his devotion to his family and to his students, his loyalty to his friends, his rugged simplicity and honesty and his invariable response to calls for service, Charles Mendenhall was a great character, an inspiration and an example, and a beloved friend.

KARL T. COMPTON

### JOHN S. CARROLL

In the sudden passing of John S. Carroll on September 15 at his home in Jackson, Mississippi, the fertilizer industry loses one of its oldest and best-known members. For more than thirty years, this Southern gentleman of the "old School" had been associated with the potash interests in agricultural and scientific work, and his friends, not only among scientific agriculturists but among the trade, were legion.

John Sharkey Carroll was born in Oktibbeha County, Mississippi, in 1871, and was reared on a farm. He studied agriculture at the Mississippi Agricultural College, graduating in 1892 with the degree of bachelor of science.

He taught in the public schools of that state for two years and was then appointed instructor at the Mississippi Agricultural College, where he pursued graduate work in agricultural chemistry, receiving in 1896 the degree of master of science. One year was spent in graduate work in chemistry at the University of Chicago.

In 1896 he was appointed to the position of assistant professor of chemistry in the Mississippi Agricultural College and assistant state chemist, with work in connection with the inspection and analysis of fertilizers. He continued in this work until 1904, when he accepted the position of manager of scientific and educational work of the German Kali Works for the Southern states, with offices in Atlanta, Georgia. Since then, with the exception of the late war period, during which time he taught chemistry at the Mississippi Agricultural College, Mr. Carroll had been connected with the agricultural and scientific work of the potash interests, and at the time of his death was manager of the Southwest Territory for the American Potash Institute.

Mr. Carroll was a member of the American Association for the Advancement of Science, the Association of Southern Agricultural Workers, the American Society of Agronomy, the American Chemical Society, and several other agricultural societies. He was also a member of several local organizations, including the Chamber of Commerce, University Club and the Rotary Club.

R. H. S.

### JOHN IGNATIUS FANZ

John Ignatius Fanz, head of the department and professor of pathology, bacteriology and hygiene, Temple University School of Medicine, Philadelphia, died on August 26, 1935, at the age of 44 years.

Dr. Fanz was born in Philadelphia on February 1, 1891. He received his preliminary education in the public schools of Philadelphia, graduating from the Central High School in 1908. He received the degree of doctor of medicine from the Jefferson Medical College, Philadelphia, in 1912, and completed his internship at the Jefferson Hospital. From September, 1914, to June, 1916, he held the position of demonstrator in biology and histology at the Jefferson Medical College. He acted as curator of museums to the same institution from June, 1916, to September, 1918. In the fall of 1915, he was appointed demonstrator and later associate in the department of bacteriology and hygiene, which position he held until the spring of 1923. During the same period, he was clinical pathologist to St. Agnes Hospital, Philadelphia. In 1923, he was appointed head of the department and professor of pathology, bacteriology and hygiene at the Temple University School of Medicine, Philadelphia, which position he held until the time of his death. In conjunction with this work, in 1928, he was appointed pathologist to the Philadelphia General Hospital. Dr. Fanz was the author of numerous papers on various pathological and bacteriological subjects.

His accomplishments were not limited to the subjects which he so brilliantly taught; he was a lover of music and all the arts; a genial man, ever a source of knowledge to his colleagues and students.

W. N. P.

### RECENT DEATHS

Dr. Neil McLeod, an instructor in the department of pathology of the University of Pennsylvania Medical School, died as the result of an automobile accident on September 23. Another passenger, Dr. Joseph McFarland, since 1916 professor of pathology, is reported to be in a critical condition, suffering from a concussion of the brain.

Richard W. Smith, professor of dairy manufacturing at the University of Vermont, was killed on September 25 in an automobile accident.

Dr. William Hamlin Wilder, professor emeritus of ophthalmology at Rush Medical College, University of Chicago, died on September 24 at the age of seventy-four years.

Hugh H. Brogan, formerly librarian of the scientific library of the U. S. Patent Office, died on September 17 at the age of seventy-four years.

Sir Joseph Chambers, retired surgeon vice-admiral of the British Navy and formerly director-general of the medical department of the navy, died on September 22. He was seventy-one years old.

Peter Kosloff, known for his exploration of the Gobi Desert, died on September 27 at the age of seventy-one years.

# SCIENTIFIC EVENTS

## RADIUM AT THE WESTMINSTER HOSPITAL, LONDON

THE London *Times* states that Westminster Hospital, already equipped with a £20,000 radium bomb for the treatment of cancer, will shortly be in possession of a new bomb containing at least double the amount of radium—namely, 4 grams—and therefore worth at least £40,000. It will be available in a few weeks for treatment at the Westminster Hospital annex in Hampstead.

Portions of the new bomb are being made in the annex workshop, and the whole will be assembled and tested there by the hospital physicist during the next few weeks. The making of the new bomb will be in itself a costly undertaking. A new tungsten alloy, one and a half times the density of lead, will be used in the construction of the hollow globe within which the radium will be concealed. This alloy, a new discovery, will enable the size to remain as at present although the weight must be greatly increased. Within the lower circumference of this globe there will be a solid gold collar. The superior density of the gold will assist in confining within a narrower compass the gamma rays which issue from the radium, and will thus prevent the rays spreading and causing injury to healthy tissues.

The present bomb has now been in use day and night for two and a half years, and over 600 patients have received more than 7,000 treatments. It has been found that there is a great advantage in working at a greater distance from the patient, and this will be made possible by the employment of a much larger quantity of radium within the bomb; the patient will receive a more effective dose at a greater depth below the surface. Minor improvements will be made in the suspension of the new bomb. New types of applicators will be introduced, and it will be no longer necessary to adjust the distance of the radium from the patient by raising or lowering the internal tube to which the radium container is attached.

For five days of the week the present Westminster bomb is in constant use throughout the whole 24 hours of each day. Three shifts of operators enable the work to go on. During the remaining two days of the week, Saturday and Sunday, the bomb is used by the physicist and surgeons for experimental work, the need for extensive research into questions of effect and dosage being always present. The new buildings in Horseferry Road will enable the radium and x-ray work now carried on in Hampstead to be brought again to Westminster. At least 1,400 square feet of space has been allotted in the plans of the new Westminster Hospital for this work.

## MIGRATORY WATERFOWL REFUGES

RECENT executive orders have established two neighborhood refuges in North Dakota that when complete will cover 80,000 acres and will be one of the largest duck-producing areas in the United States. These sanctuaries are under the supervision of the U. S. Biological Survey and are designated the Upper and the Lower Souris Migratory Waterfowl Refuges. Both are being improved by CCC workers.

The two refuges lie on the Souris River, a stream that comes out of Saskatchewan and meanders through North Dakota for 358 miles, cuts a valley 170 miles long through the heart of one of the great hereditary nesting areas of the Northwest, and then goes north into Manitoba. Prior to the disastrous drainage activities of the early 1900's, hundreds of duck hunters went to this region every autumn.

The Upper Souris Migratory Waterfowl Refuge, a 30,000-acre tract in Ward and Renville Counties, not far northwest of Minot, will contain a large storage reservoir to furnish a more uniform water supply for that area and also for the Lower Souris Migratory Waterfowl Refuge. The principal dam for the storage reservoir will be about 27 feet high, requiring 302,000 cubic yards of earth fill, with concrete and steel outlet works and a separate spillway of rubble and reinforced concrete.

The Upper Souris dam will have a storage capacity, at normal water-level, of about 112,000 acre-feet and will provide water for flood-irrigating parts of the valley that have never been agriculturally productive since the costly drainage activities of 30 years ago. Flood storage will also improve the sanitary conditions of several valley towns.

Two CCC camps on the upper refuge are constructing smaller dams, dykes, ditches, spillways and two outlet structures in the development of an 8,000-acre marsh area in the valley. They will plant food and cover and construct firebreaks, roads, fences and buildings.

The Lower Souris Migratory Waterfowl Refuge, a 50,000-acre sanctuary 70 miles down the river from Upper Souris, is in Bottineau and McHenry Counties and northeast from Minot. This refuge has greater potentialities for geese and duck production than any other area now administered by the survey. The refuge is a strip of original marsh 40 miles long and varying from 1 to 3½ miles in width. The natural depressions are filled when the spring run-off occurs, and, in the restoration, the 40-inch annual summer evaporation will be counteracted by water drawn from the large storage dam at Upper Souris. This assured water supply means that the marshes will provide food

for young ducks until they are well on the wing. A CCC camp is established on Lower Souris.

In addition to ducks and geese, the Souris Refuges winter thousands of sharp-tailed grouse that migrate from Canada with the onset of the northern blizzards. The food supply is abundant, and the sanctuaries now have a large population of pheasants, partridges and grouse, as well as rabbits, some lynx, a number of beaver, and an occasional deer. A private herd of buffalo, of 60 to 80 animals, is at present maintained on Upper Souris.

## THE CURRICULUM IN PUBLIC HEALTH AT THE GEORGE WASHINGTON UNIVERSITY

The School of Medicine of the George Washington University, of which Dr. Earl B. McKinley is dean, announces the establishment of a four-year integrated curriculum in public-health teaching to parallel its curriculum in mental health established three years ago under Dr. William A. White. The public-health curriculum has been made a part of the regular medical course for the degree of doctor of medicine, but is also open to special and graduate students in the public-health field. Courses in community health, sanitation, hygiene, preventive medicine and the public health aspects of medicine and surgery are included. The faculty is composed of the following specialists:

Roscoe Roy Spencer, A.B., M.D., associate professor of hygiene and preventive medicine, coordinating officer.

Warren F. Draper, A.B., M.D., professorial lecturer in public-health administration.

Walter L. Treadway, M.D., professorial lecturer in preventive medicine.

Royd R. Sayers, M.D., professorial lecturer in industrial hygiene.

William Charles White, M.B., M.D., professorial lecturer in tuberculosis.

Louis L. Williams, M.D., professorial lecturer in preventive medicine.

R. A. Vonderlehr, M.D., professorial lecturer in preventive medicine.

Estella F. Warner, M.D., professorial lecturer in child hygiene.

Leslie C. Frank, C.E., professorial lecturer in sanitary science.

Ralph E. Tarbett, B.S., professorial lecturer in sanitary science.

Selwyn D. Collins, A.M., Ph.D., professorial lecturer in sanitary science.

Other new appointments to the faculty and staff for the coming year include:

A. K. Balls, M.D., adjunct professor of biochemistry.

Edward Lewis, M.D., assistant professor in pediatrics.

William S. Anderson, M.D., instructor in pediatrics.

Harry A. Davis, M.D., instructor in pathology.

Elmer W. Fugitt, M.D., clinical instructor in medicine.

Madison Hunt, A.B., M.A., fellow in biochemistry.

Harry S. Douglas, A.B., M.D., research assistant in biochemistry.

Otto Behrens, M.A., Ph.D., research assistant in biochemistry.

Clement J. Rodden, B.S., M.S., microanalyst in biochemistry.

## THE AUTUMN MEETING OF THE NATIONAL ACADEMY OF SCIENCES

The autumn meeting of the National Academy of Sciences will be held at the University of Virginia, Charlottesville, on November 18, 19 and 20. This is the first time in its history of seventy-two years that the academy will have held a meeting in the South. Charlottesville is the center of historic Virginia, with the homes of Jefferson, Madison and Monroe in the vicinity. Dr. S. A. Mitchell is chairman of the local committee. Other members of the committee are: J. L. Newcomb, A. G. A. Balz, Professor Ivey F. Lewis, W. A. Nelson, Professor W. S. Rodman and F. E. Wright, *ex officio*.

Adequate hotel accommodations are available at the Monticello Hotel and at the Farmington Country Club, both of which have granted special rates to members and their families. The original Farmington home was remodeled by Jefferson. It is three miles from the University of Virginia, but taxi service will be arranged. Farmington affords a good view of the Blue Ridge Mountains.

Complimentary luncheons will be served to members and guests on Monday, Tuesday and Wednesday, November 18, 19 and 20. The receptions on each of the three afternoons will also be complimentary to members and guests.

The provisional program is as follows:

Sunday, November 17

2:30 P. M., Meeting of the Council, followed by dinner, Farmington Country Club.

Monday, November 18

*Morning*, 10:00, Address of Welcome by John Lloyd Newcomb, president of the University of Virginia. Response by President Frank R. Lillie, of the National Academy of Sciences. 10:30, First Scientific Session. *Afternoon*, 1:00, Complimentary Luncheon for members and guests, including ladies. 2:30, Second Scientific Session. 4:30, Reception, to members and guests, at the home of President and Mrs. J. L. Newcomb. *Evening*, 8:15, Public Lecture in Cabell Hall by Professor Harold C. Urey, of Columbia University.

Tuesday, November 19

*Morning*, 9:00, Tour of the University. 9:30, Business Session (for members only). 10:30, Third Scientific Session. *Afternoon*, 1:00, Complimentary Luncheon for members and guests, including ladies. 2:00, Fourth Scientific Session. 4:30, Visit to the Leander McCormick

Observatory and Tea at Observatory House with Director and Mrs. Mitchell. *Evening,* 7:00, Reception by President and Mrs. Frank R. Lillie and President and Mrs. John Lloyd Newcomb, Farmington Country Club. 7:30, Academy Dinner, Farmington Country Club.

WEDNESDAY, NOVEMBER 20

9:00, Tour of the University. 10:00, Fifth Scientific Session. 1:00, Luncheon at Castalia, the home of Mr. and Mrs. Murray Boocock. 3:00, Visit to "Monticello." 4:30, Tea at Morven with Mr. and Mrs. Charles A. Stone.

# SCIENTIFIC NOTES AND NEWS

AT a meeting of the International Union of Biological Sciences held at Amsterdam on September 2, in connection with the sixth International Botanical Congress, Dr. E. D. Merrill, retiring director of the New York Botanical Garden, was elected president, succeeding Dr. A. C. Seward, of the University of Cambridge. Dr. Merrill took up his work as administrator of botanical collections at Harvard University on October 1.

DR. JAMES F. BURKE, member of the United States National Committee of the International Electrotechnical Commission, was elected president to succeed Dr. A. F. Enstrom, Sweden, at the recent meeting of the plenary session of the commission at Brussels. Dr. Elihu Thomson and Professor Pierre Janet were elected honorary presidents; Colonel K. Edgecumbe was reelected honorary secretary.

DR. ROSCOE POUND, dean of the Harvard Law School, has submitted his resignation to take effect at the end of the present academic year. He will continue to hold the Carter professorship of law. Dr. Pound is also known for his work in botany, being a member of the Botanical Society of America, the American Microscopical Society, the Ecological Society of America and the American Association for the Advancement of Science.

G. N. CARMAN, who completed recently forty years of service as director of the Lewis Institute, Chicago, has reached the age of seventy-nine years. The title of director emeritus has been conferred on him.

DR. RICHARD VON HERTWIG, professor of zoology at Munich, celebrated his eighty-fifth birthday on September 20; Dr. Gustav Gärtner, professor of general pathology at Vienna, celebrated his eightieth birthday on September 28.

PROFESSOR P. S. SHEARER has been appointed head of the department of animal husbandry at the Iowa State College. In this position he succeeds Professor H. H. Kildee, who is now dean of agriculture. Dr. Margaret A. Ohlson, of the Michigan State College, has been appointed associate professor of foods and nutrition.

DR. ARTHUR OSOL, associate professor of physical chemistry and assistant director of the chemical laboratories at the Philadelphia College of Pharmacy and Science, has been appointed assistant dean.

DR. ERNST A. HAUSER, since 1933 chemist of the "Semperit" Austro-American Rubber Works in Vienna, known for his research on rubber and other colloidal materials, has been appointed associate professor of chemical engineering at the Massachusetts Institute of Technology.

DR. T. B. MANNY has resigned as acting head of the Division of Farm Population and Rural Life in the Bureau of Agricultural Economics, U. S. Department of Agriculture, to become head of the department of sociology and public welfare at the University of Maryland.

DR. JAMES HARRISON, instructor in bacteriology at the University of Chicago, has become assistant professor of biology at Temple University. He will have charge of the work in the department of bacteriology, of which Professor A. A. Schaeffer is chairman.

DR. EARLE G. BROWN, since 1925 secretary of the Kansas State Board of Health, has been appointed professor of hygiene and preventive medicine at the University of Kansas School of Medicine at Kansas City. He will retain his position with the State Board.

DR. E. A. HELGESON has been made assistant professor of botany at the North Dakota Agricultural College. He will be in charge of teaching and research in plant physiology and of teaching in plant pathology.

DR. E. B. NEWMAN, formerly National Research Council fellow, has been appointed instructor in psychology at Swarthmore College.

DR. E. W. H. CRUICKSHANK, professor of physiology at Dalhousie University, has been appointed to the Regius chair of physiology in the University of Aberdeen, to succeed the late Professor J. J. R. Macleod.

DR. NOLAN D. C. LEWIS, director of laboratories at St. Elizabeth's Hospital, Washington, since 1919, will become assistant medical director in charge of clinical and clinicopathological research of the Neurological Institute. Dr. Lewis, who also will become professor of neuropathology at the College of Physicians and Surgeons of Columbia University, was formerly director of clinical psychiatry at St. Elizabeth's Hospital. Dr. C. Burns Craig has been made associate director of the institute.

DR. H. S. RUBINSTEIN, who recently resigned from the faculty of the School of Medicine, University of Maryland, is now carrying on his work at the Laboratory for Neuro-Endocrine Research of the Surgical Division of the Sinai Hospital, Baltimore.

L. L. SNYDER has been promoted to the position of curator, Division of Birds, in the Royal Ontario Museum of Zoology at Toronto.

DR. WILSON G. SMILLIE, professor of public health administration at the Harvard School of Public Health, has been made chairman of the Newton Board of Health, to succeed Dr. Francis G. Curtis, who has resigned after forty-two years' service.

DR. CLAIR E. TURNER, professor of biology and public health at the Massachusetts Institute of Technology, is now in Europe on leave of absence for a year to conduct a world survey of public health education methods. During his absence the work will be carried on by three special lecturers, who were recently appointed. These are: Dr. Charles F. Wilinsky, deputy commissioner of health of Boston; Professor Percy G. Stiles, of the Harvard Medical School, and Charles F. Horan, industrial hygienist.

PROFESSOR W. W. STIFLER, of the department of physics, and Professor Harold H. Plough, of the department of biology, have returned to their posts at Amherst College after a semester's leave of absence. Professor Stifler, after traveling in France, Switzerland, Germany and Belgium, spent some weeks in study at Cambridge, England, and attended a conference of physicists in Bristol. Professor Plough spent the first half of his leave in the study of tropical marine animals at the Bass Biological Laboratory, Englewood, Fla. After that he went to California to continue his work in the field of genetics in the laboratory of the California Institute of Technology at Pasadena, later spending a month at Woods Hole, Mass.

SURGEON-GENERAL HUGH S. CUMMING, head of the U. S. Public Health Service, sailed on September 23 for Geneva and Paris. Dr. Cumming will be an unofficial observer at a meeting of the Health Committee of the League of Nations from October 7 to 16. He planned then to go to Paris for the sessions of the International Health Office beginning on October 17. Both conferences will consider methods of checking the spread of yellow fever.

W. R. GREGG, chief of the U. S. Meteorological Service, arrived in Moscow on September 21 to make arrangements for receipt of weather reports from Siberia. He was accompanied by J. B. Kincer, chief of the Climate and Crop Division of the service. It is planned to establish a systematic exchange of weather reports with the Soviet government.

THE second Harvey Society lecture will be given on November 21 by Dr. Robert M. Yerkes, professor of psychobiology at Yale University, on "The Significance of Chimpanzee-Culture for Biological Research."

THE Dohme Lectures at the Johns Hopkins School of Medicine will be given by Dr. James A. Gunn, professor of pharmacology and director of the Nuffield Institute of Medical Research, at the University of Oxford, on November 6, 7 and 8. The titles of the lectures are as follows: "Pharmacological and Therapeutic Properties of the Harmala Alkaloids and Their Derivatives," "Reactions of Uterine Muscle" and "Pharmacological Syndromes."

DR. W. W. CORT, professor of zoology at the Johns Hopkins University, opened on October 3 a series of eight popular lectures to be given before the Lancaster, Pa., branch of the American Association for the Advancement of Science. His subject was "Biological Studies in Human Parasites." Subsequent lectures will be given by: Dr. A. B. Stout, New York Botanical Garden, botany; Professor K. M. Dallenbach, Cornell University, psychology; Dr. W. J. Humphreys, U. S. Weather Bureau, Washington, D. C., physics; Dr. E. R. Weidlein, Mellon Institute, Pittsburgh, chemistry, and Professor G. H. Parker, Harvard University, zoology.

A SERIES of lectures on subjects in industrial chemistry and chemical engineering will be presented by technologic specialists of Mellon Institute of Industrial Research during 1935–1936. These discourses will be delivered on alternate Thursdays at 11:30 A. M. from October 3 to May 14, in the Fellows' Room of the institute. They will be open to all students of industrial chemistry and chemical engineering in the University of Pittsburgh, as well as to the institute's members. The lectures are: Dr. E. R. Weidlein, "Whither Industrial Research?"; Dr. F. P. Lasseter, "Fuels and Their Combustion"; H. B. Meller, "Urban Air Hygiene"; Dr. T. A. Wilson, "Radiations in the Industries"; Dr. R. N. Wenzel, "The Fatty Acid Industry"; Dr. E. W. Reid, "The Synthetic Organic Chemical Industry"; Dr. W. B. Burnett, "Synthetic Textile Products"; Dr. M. H. Bigelow, "Modern Plastics"; Dr. O. F. Hedenburg, "Vital Products and Their Synthesis"; Dr. H. K. Salzberg, "Milk and Its Derivatives"; Dr. M. D. Coulter, "Food Distribution"; Dr. Jules Labarthe, "Science in Retail Merchandising"; Dr. L. H. Cretcher, "Chemical Therapeutic Agents"; Dr. E. H. Balz, "Essential Oils."

THE eleventh International Horticultural Congress was opened in Rome by Signor Rossoni, the Minister of Agriculture, on September 16. Five hundred delegates from more than fifty states attended.

THE International Congress on Dermatology, which opened in Budapest on September 16, was attended by 1,000 physicians.

THE fifteenth annual meeting of the Highway Research Board of the National Research Council will be held in Washington, D. C., on December 5 and 6.

THE eighth annual meeting of the committee on electrical insulation of the Division of Engineering and Industrial Research of the National Research Council, of which Professor J. B. Whitehead, dean of the faculty of engineering of the Johns Hopkins University, is chairman, will meet at Pittsfield, Mass., on October 17, 18 and 19. In addition to a program of twenty-two scientific papers, there will be, after the annual dinner on Thursday, an address by Dr. Irving Langmuir, of the General Electric Company, entitled "Random Thoughts on Dielectrics." On Friday a luncheon will be tendered to the committee by the General Electric Company and there will be an inspection of the plant of the company, including the research laboratories.

THE American Public Health Association's fourth health education institute will be held in Milwaukee on October 4, 5 and 6, preceding the annual session of the association. The subject of this year's institute will be "Health Education with Special Reference to Smaller Cities and Rural Communities." Leaders of the discussions will be Dr. W. Frank Walker, director of the division of health studies, Commonwealth Fund, New York; Wesley Maurer, of the School of Journalism, University of Michigan; Evart G. Routzahn, editor of the public health education section of the *American Journal of Public Health,* and Ruth E. Grout, Cattaraugus County School Health Service, Olean, N. Y.

THE Australian Federal Government announces the immediate establishment of a Federal Medical Research Council with the cooperation of the states as a first step towards a permanent memorial of the visit of the British Medical Association. It is expected that the proposal will attract many endowments.

A REVERSIONARY bequest of $10,000 from the estate of Miss Lucy Hunter Baird has been received by the Smithsonian Institution.

FEDERAL and state forces have been continuing the drive against the Dutch elm disease. Since there is no known cure or control, complete eradication of the disease appears to be the only means of saving one of the most highly valued shade trees in this country. Government scouts have examined the trees for evidence of the disease. If a diseased tree is found and verified by laboratory tests, it will be removed before it becomes a breeding place for bark beetles that carry the disease from tree to tree. Specimens for laboratory tests must be taken from each diseased tree so that trees affected with the disease will be condemned. The tree is then marked with a small aluminum tag so that it can be identified when the laboratory report is available. If it is found to have the disease, the owner will be notified by a representative of the State Department of Agriculture. In addition to collecting specimens from wilted trees, scouts will also tag all dead and dying elms. These trees serve as a breeding place for the insect carriers of the disease as well as the fungus that causes the disease. The removal of these worthless and unsanitary elms is as important to this project as mosquito control or sewage disposal is to some human diseases. The cooperation of private property owners and public officials with the government and state agencies is requested. A recent circular outlining the eradication program may be had upon request to Room 916, County Office Building, White Plains, N. Y. Likewise all questions regarding the work should be referred to that office.

A REUTER dispatch from Berlin to *The New York Times* reads as follows: "Professors at German universities and technical and other scientific colleges have been 'muzzled' by order of Bernhard Rust, Minister of Education. They are forbidden to give information to the press on their work in experiments and research. Each university and college will have a special 'press man' who alone will be authorized to pass an answer and whose sanction must be obtained by professors for all their scientific publications."

THE London *Times* reports that after the claim by the president of the Geological Survey and Museum Scientific Staff Association for improved scales of pay for geologists employed, the Industrial Court has decided that as from January 1 the scales of pay for district geologists, senior geologists and geologists shall be £850—£30—£1,010, £680—£24—£800 and £350—£25—£650, respectively. The minimum of £350 is to apply to officers recruited at the age of 25 or over, this salary to be reduced by one increment in respect of each year or part of a year by which the age of the entrants is below 25 years. The numbers involved in the award are 50. The present salary scales of these three grades are £797–£905, £575–£797 and £337–£575, respectively. Geologists upon appointment are required to possess a good honor degree in geology, knowledge of French and German, and if possible to have done research work for a year or more. The scales awarded to district geologists and senior geologists are identical with those for senior and principal officers (scientific, technical and chemical) in the Department of Scientific and Industrial Research, the Government Chemist's Department and the scientific departments in the Admiralty and Air Ministry. The scale of the recruiting grade (geolo-

gist) is considerably higher than that for the recruiting grades of chemists and technical officers in these departments, which is £275—£18—£455 (efficiency bar)—£25—£580. In the latter case, however, a few selected officers are allowed an extended maximum of £680.

# DISCUSSION

## CONSERVATION OF THE PREHISTORIC REMAINS OF NEBRASKA

A RESOLUTION has recently been adopted by both houses of the Nebraska legislature to conserve the scientifically very valuable deposits of fossil and other prehistoric remains which occur in the state. This is not to be construed as an unfriendly move on the part of the sponsors of this act. The Nebraska Geological Survey welcomes serious scientific study and research within the state by all persons and institutions who seriously desire to investigate and collect for purely scientific purposes. There is no intention to restrict or curtail the collection of materials by properly accredited representatives of educational institutions and museums. It is hoped that this act will encourage greater cooperation and more complete understanding between scientists from without the state, who come to Nebraska, and the personnel of the Nebraska Geological Survey, the Nebraska State Museum, and other properly constituted staffs of scientists within the state. Persons or institutions who desire to collect in Nebraska should make contact with the state geologist or an authorized representative of the Nebraska State Geological Survey. No set of specific regulations are at present contemplated and such may not be found necessary, if all persons concerned cooperate to the fullest extent.

It is hoped that this act will discourage and prevent the commercial exploitation of all kinds of prehistoric remains by citizens of the state and other persons from without. Also, it is desirable to prevent the unskilled digging of fossils, *et cetera,* by untrained persons, and the exploitation of valuable deposits by any one whose motives may not be strictly scientific or whose activity may not result in the greatest possible scientific use of the materials. Amateur local collectors are not to be discouraged in their pursuit of scientific information, but museum directors, to whom collections from Nebraska are offered for sale, are advised to communicate with the state geologist regarding the status of the collector and whether authorization has been issued permitting such disposal of materials. It is hoped that all collectors and parties will fully regard the prior claims that other collectors may have, by right of discovery or by grant by other discoverers, to sites and quarries, which have been opened up in previous seasons. Greater agreement on problems of paleontology and stratigraphy will be possible now than in the past, if all geologists, paleontologists and archeologists working in Nebraska will fully cooperate with the Nebraska State Geological Survey in the spirit of the resolution which is given in full below:

RESOLUTION REGARDING THE CONSERVATION OF NEBRASKA'S FOSSIL AND OTHER PREHISTORIC REMAINS

PREAMBLE

*Resolved:*

That WHEREAS, the State of Nebraska has within its borders extensive geologic formations and other deposits containing fossil and other prehistoric remains of great scientific value, and

WHEREAS, the unskilled exploitation of these resources, by untrained workers, has resulted in the destruction of much fine material, and the permanent damage to many of the best deposits,

Therefore, authority is hereby given to the Nebraska State Geological Survey of the Conservation and Survey Division of the University of Nebraska, to regulate and control the collection of such materials within the borders of the State, and to take such steps as may be necessary under its police power, already granted, to conserve these deposits for Nebraska, and to prevent the unscrupulous exploitation of the same by collectors from without the State.

The above resolution was introduced and adopted by the Nebraska House of Representatives on the 14th day of May, 1935, and it was introduced in the Nebraska Senate on May 20 and adopted on May 24, 1935, and has been officially certified by the Chief Clerks of both houses.

A. L. LUGN,
*Geologist, Nebraska State Geological Survey, and Associate Professor of Geology, University of Nebraska*
LINCOLN, NEBRASKA

## "YELLOW WATER" IN LA JOLLA BAY IN 1935

IN the last week of July and the first week of August, 1935, a case of "yellow water" occurred in La Jolla Bay, near San Diego, California. When first noticed on or about July 27 the discoloration amounted to no more than a greenish yellow tinge to the water where sufficient numbers of causative organisms were caught in the surface films of the sea and of air or gas bubbles concentrated by breaking wavelets.

On July 30 the color was much more prominent and there were spots in which the wavelets had thrown it into frothy streaks, some narrow and others a foot or a yard in width, with colors varying from delicate olive-green-yellow outside the froth to bright yellow-

green in some of the froth traces. A pretty shade of lemon yellow was frequently visible from the pier of the Scripps Institution of Oceanography.

The color reached its greatest prominence, both as to apparent density and as to width of streaks on August 7, but it had attracted considerable attention at the La Jolla Beach Club on July 30, the bathers complaining that the water was covered with oil. At that time, in response to a request of the club management I made a direct examination of conditions at their beach, which showed that considerable areas in and near the surf did have an oily appearance to the eye, although samples of the water did not have an oily feeling. On the wet sand, receding breakers left rows of yellowish material, one to six inches wide and sometimes a quarter inch deep, which consisted of "pure cultures" of the organisms concerned.

Careful microscopic examination of samples from the water as well as from the sand showed the condition of "pure culture" to be general. No one at the Scripps Institution has been able to identify the organism, beyond showing that it was a true flagellate possessing four flagella. All specimens appeared to be very lively, dancing about in the surface film of bubbles or in the water with a movement much like "Brownian movement." As might be expected, the color of individuals was very slight, with yellow a little more prominent than green. The shape was about like that of a flat, neckless flask and the dimensions were about six thousandths of a millimeter in length by four in width.

Following the peak of abundance of the yellowish organisms on August 7 complaints began to be heard of bad odor in sea water, especially after most of the yellow color had been displaced on the beaches by one of very light brown in the traces of foam. Special examination of the brownish material showed the almost exclusive prevalence of a nearly colorless flagellate organism much larger than its predecessor, mostly three or four times as long. Its shape and action were also distinctly different. The form was more like that of a common potato, and the swimming action was very swift, though spasmodic, much like that of certain flagellates often found in stagnant or foul water on land. No satisfying identification was found for it.

Aside from the questions concerning its identity and its taxonomic relationships, the most remarkable points concerning this occurrence of "yellow water" were the exceptionally small size of the flagellate and the absence of all other plankton organisms. In the several cases of "red water" in the La Jolla region mentioned by me in SCIENCE for July 7, 1933, many other kinds of organisms were associated with the one causing the color. In this 1935 case of "yellow water" fishes near the pier seemed to be entirely indifferent to the condition, and no harm to sedentary animals was noticed.

W. E. ALLEN

SCRIPPS INSTITUTION OF OCEANOGRAPHY,
LA JOLLA, CALIFORNIA

## GROWTH PROMOTING EFFECT OF FLAVINE ON THE CHICK

ELVEHJEM and Koehn[1] have recently demonstrated that flavine is powerless to prevent a pellagra-like syndrome in chicks caused by feeding a heated diet of yellow corn meal, 58 per cent.; wheat middlings, 25 per cent.; commercial casein, 12 per cent.; supplemented with salts and cod liver oil. The syndrome was prevented by the filtrate from liver extract after the flavines were removed by adsorption on fuller's earth.

We have repeated and confirmed these results. We found that our fuller's earth adsorbate, containing flavine, failed to alleviate symptoms or to restore growth in chicks on the heated diet. The filtrate cured the syndrome.

In addition, chicks were fed an unheated diet of the same composition, except that purified casein replaced commercial casein. Slow growth took place. The growth was markedly accelerated by the addition of our fuller's earth adsorbate to the diet.

Thus it has been demonstrated that in liver extract there are present two water-soluble factors which promote growth in the chick. The first of these is the factor of Elvehjem and Koehn, which promotes growth when added to a heated diet of yellow corn meal, wheat middlings and commercial casein, supplemented with salts and cod liver oil. The second factor is flavine, which has no effect when added to this diet, but which promotes growth when added to an unheated diet of yellow corn meal, wheat middlings and purified casein, supplemented with salts and cod liver oil. The two factors are distinct from vitamin B ($B_1$). Growth promotion in chicks has also been obtained with crystalline flavine (vitamin G), prepared as described by Lepkovsky, Popper and Evans.[2]

SAMUEL LEPKOVSKY
THOMAS H. JUKES

UNIVERSITY OF CALIFORNIA
BERKELEY AND DAVIS

## A NEW VARIETY OF BLACK LOCUST

IN New England, New Jersey, and especially on the northern and western portions of Long Island, there has been noted a variety of *Robinia pseudoacacia* L. that differs decidedly from the common types so widely spread over eastern and central North America. Because of its especially straight form of growth and its adaptability for planting in erosion control work

[1] *Jour. Biol. Chem.*, 108: 709, 1935.
[2] *Jour. Biol. Chem.*, 109: liv, 1935.

wherever black locust is suitable, this variety is being intensively studied by members of the Department of Agriculture. It differs not only in bark, stem and flower characters from the other described varieties of this variable species, but also in the exceptional durability of its wood when in contact with the soil. The description of this variety will be published later in a circular of the U. S. Department of Agriculture under the name of *Robinia pseudoacacia* var. *rectissima*. The botanical study of this new variety was conducted by Dr. Oran Raber for the Division of Plant Exploration and Introduction, Bureau of Plant Industry.

B. Y. MORRISON

### EFFECT OF RADIUM RAYS ON LIVING CELLS

IN the "Science News" department of SCIENCE for August 16, 1935, page 26, there is an item from Science Service on "The Effects of Radium on Cells." This note is based on the published work of Professor Frederick B. Flinn. The item contains these statements: "The effects of radium on living cells are always in the direction of breakdown and death; its powerful radiations, principally of alpha particles, *never act to stimulate more active growth*. . . . In no case was it found that a radioactive solution, even the weakest, was stimulative of extra growth."

In correspondence with the writer Professor Flinn confirms the correctness of this report of his results[1] and states: "My work with radium was with chicks' embryonic cells and I found no evidence of any stimulating effects in the presence of radium. This has also been confirmed by observation in the human beings and animals. These observations have been more or less confirmed by the Speer Laboratory in England. I did very little work with plants, but the work that I did do did not lead me to believe that there was any stimulating effect."

In his paper above cited from the *American Journal of Cancer,* Professor Flinn says (p. 357): "The experiments here described yielded no evidence of direct stimulation by the amounts of radium to which the cultures were exposed. . . . Plant growth has at this time been judged in a qualitative manner, but at the end of six months there was no indication of a stimulated growth."

Since the inference that radium rays "never act to stimulate more active growth" is directly opposed to conclusions based on extensive studies with plants, it is thought worth while to call the attention of others (who may be engaged in research on the physiological effects of radium rays) to these contrary conclusions, based chiefly on work with animals and man.

The writer's pioneer work is embodied in Memoirs of the New York Botanical Garden, Vol. IV, 1908. A summary, also by the writer, of work on the effects of radium rays on the life processes of plants since the discovery of radium by Madame Curie is now in press and will be published shortly under the auspices of the National Research Council.

C. STUART GAGER

BROOKLYN BOTANIC GARDEN

[1] *Radiology,* 23: 331–338, 1934; and *American Journal of Cancer,* 22: 351–358, 1934.

### GERMAN BOOKS AND PERIODICALS

SUPPLEMENTING the announcement in SCIENCE of July 12, 1935, I have been informed by an official of the German government that the 25 per cent. reduction on German books, periodicals and continuations became effective beginning September 9, 1935.

Contrary to previous advice, I understand that this reduction will be granted to all foreign purchasers of German books and periodicals and not limited to libraries alone. The letter reads in part ". . . *auf das gesamte buchkaufende Publikum* im Ausland auszu*dehnen*. . . ." The italics are mine.

CHARLES H. BROWN

IOWA STATE COLLEGE LIBRARY,
AMES, IOWA

## SCIENTIFIC BOOKS

### OUR REMOTE INTELLECTUAL ANCESTRY

*Primitives and the Supernatural.* By LUCIEN LEVY-BRÜHL. New York: E. P. Dutton & Co. Pp. 405. $5.00.

CULTURES near to our own we interpret as philosophies; older, alien, simpler ones as anthropology. They are all products of the same cerebrating organ. That insight is one of the many wisdoms of the neo-moderns, ourselves.

To determine which of the extinct anthropoids is the presumptive ancestral *homo* is a matter of contentious evidence; to restore the ancestral order of *sapience* that gave him the rest of his appellation is no less so. The evidence is the reports of observant travelers, latterly of trained ethnologists, in regard to the beliefs and customs of tribes still believing and still behaving more or less according to the hypothetical prime-ancestral pattern.

To our modern critical eyes, the reconstructed physical appearance of the earliest anthropoid that could prophetically claim a place in human genealogy does not look invitingly human; and the accounts of his brutal habits and strange designs for living render

him still more suspiciously remote. Turning from the frank exhibits in the cases of natural history museums to our own reflections in the nearest convenient mirror, we are impressed by the drastic measures of anatomical improvement, plastic surgery and the attentions of "beauticians" that must have intervened to convert that picture into this. The transformation in mental complexion is even more radical; still more incredible that creatures so savage and perverse in custom, so superstitious and perverse in belief as those reported by the tomeful from all quarters and nooks where unredeemed humanity has been visited, are the ancestral representatives of the professors and scientists who write these learned books. Such, however, are the findings of cultural anthropology; on such physical and mental frameworks the evolutionary powers that be have had to build the present superbly erect and correct specimens of groomed intelligentsia to which the mirror testifies.

One section of this fascinating field, where myth and fancy, crude mentality, naked and unshamed, ogres and demons fill a crowded stage, Professor Levy-Brühl has made peculiarly his own. To "Primitive Mentality" and "The Soul of the Primitive" he now adds "Primitives and the Supernatural."

The psychological interpretation of primitive mindways began in the Victorian seventies, when Sir Edward Tylor, in his "Primitive Culture," introduced the concept of animism to refer to the universal habit of the primitive mind to regard all things as animated by indwelling spirit. Animism is spirit-belief. Levy-Brühl, admitting the pertinence of the approach and using "animistic" as the best available adjective to describe the attitude, basically corrected the underlying principle by calling it "psychic participation"; for "animism" is somewhat false and wholly inadequate to summarize the temper of primitive mentality. The terminology can only be a loose fit, since we who create it look through the cultural opera-glasses of our own manufacture, think in one conceptual language and the people regarded through said glasses in another. Their cultural compulsions and ours are mental light-years apart.

The validity of Levy-Brühl's diagnosis is amply attested by his rich documentation. Once the physical and the psychical are distinguished, one may formulate that the primitive mind reads the psychical into all nature, including the physical; he projects the subjective on to the objective; he animates and animizes. But, says Levy-Brühl, that is not how the matter stands in the mind of the "native." Such distinction has not yet emerged in his vague, foggy consciousness. There is no identification, since all phenomena are of one order, which is essentially what we call psychic.

Obviously, to carry on at all, our jungle ancestors had command of large collections of data. Since what they consider nature is not consistent with our views, we call that domain of thought supernatural. As best we can, we must restore the state of mind to which it was not so. We must realize that the minds of natives are otherwise oriented. What to us is vital and common-sensical is to them secondary and unconvincing. Through slow centuries of laborious education we have acquired the corrected perspective of our science. Fortunately for sympathetic understanding, the great masses of minds have not taken kindly nor wholeheartedly to the reconstruction; the "tabloid" mind is a fair stay-at-home substitute for those who can not observe at first-hand Tahitians or Esquimaux, Australian bushmen or the jungle-folk of Africa. The core of unredeemed humanity is with us yet; the caveman is no deader than superstition.

The contours of Levy-Brühl's primitive mentality make a recognizable portrait. The decisive cast of the composition is emotional. The native is affectively tense; his thinking is in the service of his feeling; and the greatest of these powerful affects that stir the savage breast is not soothing music but exciting fear. He lives in a reign of terror with an annex of a home-made inferno. Sky, storm, floods, thunder, lightning, plagues, are real enough, but the punishing, avenging forces back of them, the evil spirits, even more so—and always there is the mystic calamity, death. The idea of a natural death is beyond him; if a man dies, somebody has bewitched him. The center of activity never moves far from the pursuit of immediate existence. To some men at some time come these dire fates; others are exempt, immune, avoid them. Points of refuge in this troubled danger-zone are sought. To coax, invite, secure good fortune, to evade, deflect ill fortune: that is the to be or not to be of the pre-Adamitic Hamlet.

And his answer is an elaboration of luck ceremonials, charms, amulets, talismans, rituals of appeasement and "superstitious" wardings-off innumerable. Visible and invisible are all alike, the genius in him and the madman of a nature all compact. Every article of clothing, every act of sustenance from hunting and trapping to planting and reaping, from gathering to cooking and eating, is set in a ceremonial of fear, the avoidance of bad luck, the propitiation of good luck. It is all magic—mana and miasma—so far as effective agency goes; there is also a tincture of reflection, but mainly not his to ask the reason why, just to do or die, or do something else to avoid that fate. Yet the still small voice of connection—what in the academic alembic becomes cause and effect—will make itself heard. Observation records that this arrow has repeatedly brought down the prey—it must be lucky or blessed; that arrow has failed—a blight

hangs on it; thus there emerges a groping sense of rule in good and evil; as in survival superstition divides them into horseshoes and four-leaf clovers and picking up pins and black cats, peacock feathers and breaking mirrors. Just carry that attitude into the thousand-and-one details of your eight-hour-a-day occupation, and imagine what life would be, until you were adjudged *non compos mentis* by your employer and the authorities. If they were similarly affected, the forces of law and order which they represent would not exist.

There is a further clue to primitive mentality which Levy-Brühl calls *dispositions*. How are things, times, localities, operations, events disposed toward you? For everything is disposed to make or mar. Primitive psychology is disposology-reading intentions; and applied psychology is the wisdom of attracting favorable dispositions and avoiding, sidetracking, scapegoating unfavorable ones. The two chapters on dispositions are the richest in the book. Examples are innumerable and striking. A striking one from Tahiti is the tale of a white man spending a night in the cave of a hermit, Afaiau. His host covers him with a coat, as the night is cold, later mentions that the garment belongs to a leper. "I jumped to my feet—reached for the rum bottle—to pour it over my hands and feet for disinfection."

"Why are you so excited and worried? My only intention was to convey comfort to you when I gave you that tunic, and not to convey the disease of its former owner." Disposition determines effects.

Disposition sets the plot of a hundred dramas of the constantly dramatic primitive life. Ceremonials and dances are elaborate rituals for creating dispositions; ancestor worship is based on the same principles, making the dispositions of the dead vital for the living —lest their ghosts haunt.

But be careful as you will, disaster stalks night and day; the fear world casts spells. The cause of causes is bewitchment. Sorcerers abound; unsuspected, another or you yourself carry the Evil Eye. Punishing witches, devising counter-witchcraft becomes the great primitive practice. Moreover, try as you will not to, you will transgress, violate a taboo, and then must be applied the purification ceremonies—a Bible in their wealth of prescriptions. Between fearing, avoiding and purifying, the primitive man spent his days, entangled in the web of his own psychology. Much of this ceremonial is entirely out of the horizons of our understanding. Purification by blood produces a rich, weird and mystic magic. And so the tale goes on and on and never ends.

It is a wholesome discipline for neo-modern sophisticated, privileged, informed and clarified minds to contemplate the crude and cruel practices, the weird and bizarre products of belief, groping in bewilderment for some shelter of sanctuary in a troubled and hostile world. Such are the beginnings of our intellectual heritage. From this somehow, as mind was in the making, evolved the orderly world of orderly understanding and reasonable security. Wonderfully and fearfully made indeed is the mind of man and its employments, and equally so the story of how the rough road became a safe and speedy highway of thought.

JOSEPH JASTROW

# SOCIETIES AND MEETINGS

## THE SEVENTH AMERICAN SCIENTIFIC CONGRESS

UPON invitation of the organizing committee appointed by the Department of Public Education of the Republic of Mexico, the United States and its various scientific societies were invited to meet in Mexico City from September 8 to 17 to participate in the seventh American Scientific Congress. The United States Government designated the following delegates: Dr. Wallace W. Atwood; Dr. J. McKeen Cattell; Dr. Franklin S. Harris; Professor Edward V. Huntington; Neil M. Judd; France V. Scholes; Dr. Cloyd H. Marvin, *Chairman;* William W. Schott, *Secretary.*

In addition there were delegates from forty-five universities and scientific societies of the United States. Most of the delegates were appointed in response to an invitation from the Department of State extended through the American Association for the Advancement of Science.

The congress was opened at the Palace of Fine Arts, and at the first plenary session the eminent geologist, Dr. Pedro C. Sánchez, president of the organizing committee of the congress, outlined the history of past scientific congresses. His address, like those of President Cardenas and Secretary Ponton, was given in Spanish and subsequently translated into English. The following is an extract from Dr. Sánchez's address:

> The first scientific congress took place at Buenos Aires in 1898, convoked by the Hispanic-American countries, at the time of the silver jubilee of the Argentinian Scientific Society. It was said then that the isolation of Spanish America must cease, an isolation which was, in practice, worse than barbarousness: for nobody was interested in the intellectual life of the Hispanic-American

people, least of all they themselves. It was necessary, so said the Argentinians at the end of last century, to multiply the libraries and supply them properly with books, to support the universities, which are the home of research and the seed-beds of knowledge, and then, to come into contact and touch with intellectuals of other countries, in order jointly to erect the house of science and mutual understanding. After the Buenos Aires Congress of 1898, one was held in Montevideo in 1901, in Rio de Janeiro in 1905, and in Santiago de Chile in 1908, at which more than 2,000 intellectuals from the whole Continent were present. This Congress in Santiago de Chile was the first one which could really be termed a Pan-American one. After this followed the one held at Washington, D. C., in 1915, then one at Lima, Peru, in 1924, and this one, the seventh, being inaugurated to-day in this year of 1935 in Mexico City. These congresses have extended the frontiers of science and laid the foundations for permanent friendships between intellectuals of the whole continent.

Following the plenary session, General Lázaro Cárdenas, President of the Republic of Mexico, formally opened the congress with the following address:

Upon initiating your important work in the seventh American Scientific Congress, I have the honor to appear before the delegates to welcome you most cordially, and to manifest to you that the Government over which I preside is deeply interested in the movement which to-day brings together the most distinguished men of science of the continent.

Confirming these sentiments of cordial and sincere hospitality, I feel called upon to state my firm conviction that it is eminently useful to revolutionary Governments such as the one over which I have the honor to preside, to be able to base their actions on an exact, concrete and scientific knowledge of their real environment. Analyzed and studied in such assemblies as this, conclusions are arrived at which will favor the working classes, giving their problems a clear social justification and unifying the different standards of continental government into one mass consciousness, forging thereby a true and lasting link in the anxiously sought-after fusion of the peoples.

This is gathered from the very summons to the Congress, in which all the representatives of human knowledge are called to a contest of intelligence, from which a cultural unity will result; the ideal of scientific American progress will be resolved, and the unknown qualities of our sociology will be defined in order that the leaders of these peoples do not have to continue seeking blindly for the truth and scope of such problems, inasmuch as scientific investigation, carried out by well-prepared persons with all the instruments of technical knowledge at their command, will permit us to arrive at a just valuation of the needs, and an actual and positive opinion of our future.

May my voice carry a cordial greeting to all the sons of this continent, together with the firm conviction of the Mexican nation that this congress will serve to strengthen the bonds of race and of culture until the dispersed peoples will be united in a harmonious whole, one continent with full consciousness of its destiny and a noble desire to fulfil it.

Finally, may this assembly have the success that its high purpose deserves.

President Cárdenas's address was followed by the address of Licenciado Luis Sánchez Ponton, secretary general of the congress; in it he said:

In the name of the organizing committee of the seventh American Scientific Congress that has worked with the most earnest help under the auspices of the Ministries of Foreign Affairs and Public Education, I have the pleasure to extend the most cordial welcome to the distinguished official representatives, delegates from universities and cultural institutions and men of science of this continent, who answered our call, and to offer them the friendly and hospitable hand of the men of learning and of the students of Mexico.

Mexico is again honored by the visit of delegates from sister countries of America, who gather under our sky to meet each other and to discuss within the boundaries of the most noble friendship the problems that preoccupy the people of this hemisphere. Mexico has enjoyed, during the last few months, the privilege of being selected as the meeting place of the most important assemblies of international character, some of world importance and others of local character, and the congresses that meet this year will make of Mexico, at least temporarily, the essential point at which the most distant men and ideas may live for a few moments, if ephemeral in their formal aspect, eternal regarding their final results.

But, at this gathering we are not going to hear the voice of men who are here to tighten the bonds of economic interests or of those sectors devoted to solve the problems of only one branch of science. Men, representatives of all the American nations, eminent workers in all the fields of learning, are the ones who constitute this congress, men of different races, nationalities, trends of thought, etc., but strongly bound by a sole and identical preoccupation, that is, the unselfish search for truth.

Here we are on a new stretch of the road which, almost four decades ago, the intellectuals of the continent first trod when holding the first assembly of this kind at the capital of the sister Republic of La Plata, convened by the "Argentinian Scientific Society."

In response to the welcome given by the President of the Republic and the secretary general of the organizing committee of the congress, the chairman of the delegation from the United States, Dr. Cloyd H. Marvin, spoke as follows:

On behalf of the delegation of the United States of North America to this seventh American Scientific Congress, I express our sincere gratitude for the hearty welcome which has just been extended to us. I take this opportunity to assure our sister republic and our hostess,

as well as those who make up the membership of this splendid gathering of investigators, that those of us who have the honor to represent the United States and its various scientific societies have come to Mexico with the hope that we may return to our homes with the satisfaction of having established more intimate personal ties with the intellectual investigators from the other American states here represented.

We earnestly desire to be colleagues in a very true sense. We look eagerly to this possibility for the interchange of ideas that grow out of the discussions of our respective investigations. We believe that in our strengthened friendships and in our exchange of scientific findings we are certain to build an understanding and a trust that will make for a finer and more effective cooperation between the leaders in learning in the Americas.

We can not overestimate the importance of the place or time of this congress. It is fine that our immediate and good neighbor, Mexico, has extended the invitation to the congress at this time. It seems peculiarly fitting that this country, which now is especially interested in the advance of scientific knowledge, and which has an understanding of both our continents, should be our meeting place. Whatever may be the contributions to knowledge made here, two things, over and above such contributions, will stand out: first, the furthering of understanding and good will among peoples of the western hemisphere; and second, the example in a community leadership for freedom.

This seventh American Scientific Congress meets at a period when the countries of Europe have cut themselves off in a large measure from intellectual intercourse, when, in fact, many of them have stifled thought within their own borders. The American republics must take again a leadership by furnishing an example of the maintenance of freedom of thinking and the free interchange of thought among nations. Just as the Americas in the nineteenth century championed the cause of democratic government, so, to-day, they must carry the torch of the republic of learning which is not a delimited preference having geographic or national boundaries, but rather a World State dedicated to the cause of the progress of mankind.

We are glad to have the privilege of meeting with you.

The congress was organized in fourteen sections, which were as follows: Physics and Mathematic Sciences; Geology; Engineering; Industrial Chemistry; Agricultural Sciences; Biological Sciences; Medical Sciences; Hygienical Sciences; Anthropological and Historical Sciences; Economical and Social Sciences; Educational Sciences; Bibliography; Indianism; Juridical Sciences. In addition to the scientific program the delegates were invited to a reception given by the Minister of Foreign Affairs, a visit to San Juan Teotihuacán, where luncheon was served, with the Minister of Public Education as host, a visit to the Cacahuamilpa Caves and to Cuernavaca, where luncheon was served, with the Minister of National Economy as host. A reception was held at the National Palace on the evening of September 15, to celebrate Independence Day on the 16th; the final hospitality offered was a luncheon at Xochimilco, with the chief of the Department of the Federal District as host.

The congress proved to be an important one in the annals of inter-American congresses. There was not a member of our delegation but who left with a higher appreciation of the scientific work that is being done in the Hispanic-American countries. More intimate personal ties were made between the several intellectual investigators of the various states. In this congress, more than any other that has been held up to this time, there was a definition of the contributions that could be made to science in common by the several nations. By common consensus this contribution is to be found in the fields surrounding archeology, ethnology, geography and history. Our appreciation of this position was emphasized by an official invitation tendered by Dr. Wallace W. Atwood on behalf of the United States Government when he invited to the second Pan-American Congress of Geography and History to be held in Washington, D. C., from October 14 to 19, delegates from Mexico and other Iberian American States.

Cloyd H. Marvin
George Washington University

# SPECIAL ARTICLES

## EXPERIMENTAL DISSOCIATION OF THE EFFECTS OF ANTERIOR PITUITARY GLANDS OF VARIOUS SPECIES ON THYROID AND OVARY[1]

Substances present in anterior pituitary glands of various species induce the following changes in ovary and thyroid gland of the immature guinea pig: (1) An intensified growth and maturation of follicles, which reach a very large size; this is associated with a diminution in the usual degenerative changes in the granulosa of other follicles. This process may be followed by a rupture of follicles and formation of normal corpora lutea in certain cases. (2) The opposite effect, a rapid and generalized destruction (atresia) of follicles, often associated with slight increase in the size of remnants of theca interna which normally constitute

[1] From the Department of Pathology, Washington University School of Medicine, St. Louis, Mo. These investigations were carried out with the aid of a grant from the International Cancer Research Foundation and with the aid of a grant for research in science made to Washington University by the Rockefeller Foundation.

a part of the medulla of the ovary, so that rudimentary strands of so-called interstitial gland develop, and also associated occasionally with the formation of small pseudocorpora lutea. The latter are not caused by ovulation of mature follicles, but by the growth of connective tissue and capillaries from the theca interna into the granulosa, both these cell layers enlarging and becoming lutein-like. (3) Type I of luteinization, consisting in the ingrowth of connective tissue and vessels from the theca interna into the enlarged granulosa of mature follicles. Thus there develop at first pseudo-lutein bodies containing still a large cavity and pearls of granulosa cells enveloped by connective tissue cells; gradually these bodies become transformed into large pseudocorpora lutea. While the cells of the mature granulosa produce follicular hormone, the lutein cells produce lutein hormone. (4) Type II of luteinization. Here we find, in addition to a marked development in the medulla of the ovary of interstitial gland from remnants of theca interna structures, a premature maturation of the granulosa of smaller and medium-sized follicles. At the same time the theca interna luteinizes around the granulosa and sends connective tissue and vessels into the latter. Thus there develop either small pseudocorpora lutea or, if the granulosa is less advanced in luteinization than the theca interna, processes take place which may be designated as luteinizing atresia of follicles, in which the luteinization of the theca greatly preponderates over that of the granulosa. These changes may in the end lead to the formation of interstitial gland bodies consisting largely or almost entirely of completely atretic follicles surrounded by zones of lutein tissue.

The anterior pituitaries of cattle, pig and sheep produce in the ovary of the guinea pig, almost exclusively, process 2; they also induce marked hypertrophy of the thyroid gland. The anterior pituitary of the guinea pig induces preponderatingly process 1 and leads to formation of rudimentary interstitial gland in the medulla of the ovary; stimulation of the thyroid gland is lacking or very weak. The anterior pituitaries of rabbit, rat and cat induce processes 1, 3 and 4; they cause only a moderate stimulation of the thyroid gland. Human anterior pituitary acts similarly to this last group, but in addition it exerts usually a more marked stimulating effect on the thyroid gland, which is perhaps due to its large size. We also notice that the relative preponderance of processes 1, 3 and 4 may vary according to the condition of the individuals from whom this organ is obtained.

In a series of experiments with human and cattle anterior pituitaries—the former being obtained at autopsy—we have now been able to change experimentally the preponderance of the various effects, which the anterior pituitary glands of these different species exert, after implantation into the guinea pig and to make the action of the gland of one species like that of another species. For this purpose we placed under as sterile conditions as possible a human or cattle anterior pituitary gland into a certain solution, where it was kept at room temperature for variable periods of time, usually 3 or 7 days but in other cases only 1 day, and in one case as long as four weeks. Following this period the gland was cut into four pieces, which were implanted, one piece at a time, on four successive days into subcutaneous pockets of sexually immature guinea pigs. On the fifth day the thyroid gland and the sex organs of these guinea pigs were removed for microscopic examination, the ovaries being cut into complete serial sections.

Some of the principal results obtained so far may be briefly stated as follows:

(1) Many different substances, such as $H_2O$, 0.9 per cent. NaCl solution, alcohol, ether, glycerine, dilute solutions of formalin, abolish process 2 (injury to follicles), which cattle, pig and sheep anterior pituitaries normally induce in the ovary of the guinea pig. Pieces of cattle gland, thus deprived of their typical effects, act now on ovary and thyroid essentially like the anterior pituitary of one of the other species; the character of these changes varies in accordance with the nature of the solution to which the gland has been exposed.

(2) While thus 95 per cent. alcohol abolishes the action of the follicle-injuring substance, normally demonstrable in implanted pieces of cattle anterior pituitary, it can be shown that this substance is still present in the anterior pituitary tissue, although it is inactive after implantation. It can be extracted with alkali, but not with weak acid, and such alkali extracts of treated cattle anterior pituitary exert their usual effects, namely, follicular atresia in the ovary and hypertrophy in the thyroid of the guinea pig. Whether this substance, in general, which is present in pieces of anterior pituitaries of cattle, sheep and pig and which can be extracted from these organs, functions as a hormone in the living organism needs still to be determined.

(3) A solution of ½ per cent. or 1 per cent. formalin, the optimum concentrations varying under different conditions, acting for from 3 to 7 days on human or cattle anterior pituitary, abolishes entirely or almost entirely effects 3 and 4 (luteinization types I and II) as well as the thyroid stimulating effect, whereas the follicular growth and maturation processes may be present in full strength. After having acted for only 1 day, these solutions have not yet abolished luteinization and thyroid stimulating effects. An excess of formalin may injure also the growth and maturation

processes. Even a solution of 1½ per cent. of formalin in 95 per cent. alcohol may exert these effects on human anterior pituitary. Solutions of formalin in $H_2O$ or 0.9 per cent. NaCl solution, especially after addition of a small amount of alkali, act therefore in principle in about the same way on human and on cattle anterior pituitaries and make both similar in their action to the anterior pituitary of the guinea pig.

(4) If human or cattle anterior pituitaries are placed for several days in $H_2O$, 0.9 per cent. NaCl or glycerine, effects 3 and 4 (types I and II of luteinization) are accentuated, while process 1 (follicular growth and maturation) is weakened. Anterior pituitaries thus treated also stimulate the thyroid gland. After an immersion lasting 1 day in these solutions, the maturation effect may still be present.

(5) Likewise, 50 per cent. or 95 per cent. alcohol and ether, acting for 3 to 7 days on cattle or human anterior pituitaries, cause a predominance of the I and II luteinization processes in the effects exerted by these glands; also the thyroid gland is stimulated. In some cases growth-maturation processes may be combined with luteinization processes and occasionally even an injurious action on follicles may be noticeable. Human anterior pituitary kept for four weeks in 95 per cent. alcohol may still produce strong luteinization effects of type II. If the anterior pituitary is exposed to the action of 95 per cent. alcohol for only 1 day, growth-maturation processes may be marked. There was observed usually an inverse relation between the hypertrophy of the thyroid gland and the intensity of the growth-maturation process in the ovary.

(6) Of the other substances tested we shall mention only 50 per cent. alcohol saturated with $Na_2SO_4$; the effects of this solution on human anterior pituitary may be similar to those which weak solutions of formalin exert, although they are not so pronounced in the former solutions as in the latter.

(7) While thus, as a rule, there was a definite correlation between thyroid hypertrophy and luteinization processes, especially of type II or with injury (atresia) of the ovarian follicles, and an inverse correlation between thyroid hypertrophy and growth-maturation of follicles, it was possible, as we have seen, to separate experimentally the thyroid-stimulating hormone from the substance producing atresia of follicles; the former was still active in cattle anterior pituitaries which no longer injured the ovarian follicles. In some cases it was also possible to disassociate experimentally the thyroid-stimulating hormone from the hormone or hormones causing luteinization processes types I and especially II. Furthermore, the previously untreated anterior pituitary gland from a woman who had died during the period of lactation produced only very marked follicular growth-maturation effects but no luteinization processes and still it exerted a strongly stimulating action on the thyroid gland.

We may therefore conclude that while usually the thyroid-stimulating hormone is in some way associated with the luteinizing hormone and with the follicle-injuring substance—a relation to which we called attention several years ago[2]—this connection is not a necessary one, an experimental dissociation between these various effects of the anterior pituitary being possible and occurring also under natural conditions in certain cases. The thyroid-stimulating hormone is therefore in all probability not identical with the luteinizing or follicle-destroying substance.

(8) These experiments have shown that it is possible to transform the action of the anterior pituitary of one species into that of another species and that the presence of one substance in the anterior pituitary may cover up the presence of other substances which become manifest after experimental removal of the first substance.

(9) The data obtained may be interpreted by assuming that the effect of these various hormones depends upon the presence of certain amino-acids, which form part of one or several polypeptid or protein molecules. The amino-acids, responsible for the stimulation of the thyroid and for the luteinization processes, especially of type II, would be very similar in constitution and, therefore, would be affected by formalin in a similar manner. On the other hand the chemical group responsible for growth-maturation processes would be more resistant to the action of formalin. We consider this interpretation merely as a suggestion, which may perhaps be serviceable in explaining the results of these investigations.

Leo Loeb
W. C. Anderson
John Saxton
S. J. Hayward
A. A. Kippen

## TRAVERTINE DEPOSITING WATERS NEAR LEXINGTON, VIRGINIA

The travertine depositing waters of the lower, cascading part of Wilson Falls Creek, 18 miles northeast of Lexington, Virginia, are supersaturated with $Ca(HCO)_2$ throughout the year, the excess ranging from about 68 to 76 parts of $CaCO_3$ per million. Not counting high-water periods, the largest excess appears in winter. These conclusions are based on monthly analyses of the creek and of a feeder spring over a span of one year. The creek was sampled at 4 stations. The first and last stations are about a mile

[2] Leo Loeb and R. B. Bassett, *Proc. Soc. Exp. Biol. and Med.*, 27: 490, 1930; Leo Loeb, *Endocrinology*, 16: 129, 1932; *Proc. Soc. Exp. Biol. and Med.*, 29: 642, 1932.

apart, and their vertical interval is about 300 feet. The drop between the second and third stations, at the top and bottom of Cypress Falls, respectively, is 130 feet.

The annual range of the pH, temperature, free $CO_2$ and of some other constituents of spring and stream are given in Table 1. Column 5 shows the $CaCO_3$ content assigned by theory to saturated solutions having the temperature range indicated in column 3 and a partial $CO_2$ pressure of .0003, this partial pressure being about the same as the nearly constant $CO_2$ pressure of the air. All compounds are given in parts per million.

TABLE I

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| | pH | Free $CO_2$ | Temperature | $CaCO_3$ | $CaCO_3$ saturated solution | $MgCO_3$ | $SO_4$ | Cl |
| Feeder spring ........ | 7.1 | 19 | 11°–15° C. | 165–190 | 65–68 | 41–52 | 1 > 5 | tr |
| Wilson Falls Creek .. | 7.8–8.4 | 0–3 | 6.5°–25° C. | 123–156 | 55–80 | 37–86 | 1 > 5 | tr |

At temperatures below 8° C., the $CaCO_3$ content was about the same at all stations, indicating no deposition. Likewise, pH and free $CO_2$ content showed the least variation at the lowest temperatures. The summer record shows the greatest differences between stations. The lowest pH and the highest free $CO_2$ and $CaCO_3$ came from the highest station. $CaCO_3$ was lowest at the last station, while pH was highest at the base of Cypress Falls as a rule. The latter also recorded $CO_2$ lacking or very low. The greatest difference in the $CaCO_3$ of the first and last station was about 25 parts per million.

The creek waters are highly supersaturated $Ca(HCO)_2$ solutions because the inflowing spring waters are even more supersaturated and because the adjustment of such solutions to the partial $CO_2$ pressure of the atmosphere is amazingly slow. Note the low pH, and the high free $CO_2$ and $CaCO_3$ content of the spring in the preceding tabulation. The supersaturation of the springs is believed to result from the high partial $CO_2$ pressure of soil and subsoil gases, reported as commonly ranging from 30 to 270 times greater than that of the air. That this high $CO_2$ content of subsurface gases is in some direct relation to the humus cover is shown by springs in unbroken forest having the highest concentration of $Ca(HCO)_2$ in the Lexington area.

The marked deposition of calcite by the summer waters is due mainly to rise in temperature. The summer waters are warmer than the spring waters, and this hastens adjustment. Adjustment is also hastened by aeration and close contact of the water with calcite, but these factors are in effect at all times. Contact with calcite is most effective at low-water stages. A solution with 200 parts of $CaCO_3$ per million and only a few parts of free $CO_2$ was adjusted, that is, reduced to saturation, by vigorous aeration in the presence of calcite in 28 hours. When aerated without calcite, the same solution still had an excess of 15 parts per million after 19 days of aeration. Aerated solutions when placed in stoppered flasks with calcite for 20 to 48 hours lost CaCO when the concentration was more than 80 parts, initially. There was no air space above the solutions. The greatest loss in the flasks was 40 parts per million and came after the first and second hour of aeration. $CO_2$ was liberated in the flasks, but the amount liberated was much smaller than it should have been if the $CaCO_3$ lost from the solution had been in the bicarbonate form. The carbonate radicle seemed to be absent. The facts suggest that much of the $CaCO_3$ which appeared to be in solution was really in a crystalline colloidal state, too fine grained to be retained by the filter. Check samples of the aerated solutions when placed in stoppered flasks without calcite did not lose $CaCO_3$. Calcite also hastened the adjustment of supersaturated solutions when standing quietly in air. With calcite the rate was nearly doubled.

The floral film of the cascades, mostly algal at present, can have but little effect on the adjustment of the relatively thick sheet of water sweeping over it. Prior to cultivation and the present entrenchment of the streams, plants may have been more effective. Then the waters were spread out in thin films, trickles and drips. Calcite is not deposited upon the growing top foliage, but upon the basal part of the plant, and even more upon the stifled foliage underneath. Travertine grows from the base up by addition of calcite to calcite, which seems to be a result of the catalytic action of calcite on unstable $CaCO_3$ solutions. By this addition of calcite to calcite, the rootless plants of the cascades become rooted and live more securely. In turn, the plants form both a framework and a protective cover for the growing travertine, a unique example of mutual aid between the organic and the crystalline.

The writer is indebted to coworkers at the Virginia Military Institute and to the Virginia Academy of Science.

EDWARD STEIDTMANN

VIRGINIA MILITARY INSTITUTE

# SCIENTIFIC APPARATUS AND LABORATORY METHODS

## A ZIPPER TUBE FOR HOLDING SMALL LIVE ANIMALS

The development of this apparatus resulted from an effort to find a satisfactory method of holding and quieting ground squirrels while marking and measuring their incisor teeth. Such work has sometimes been done with the use of an anesthetic, but it was thought preferable to avoid this factor since it might affect the results. After some preliminary experimentation, the senior author sketched out the following device, which was made by the junior author, and it has been used with much success in handling and weighing both ground squirrels and rats.

The cone-shaped or projectile-shaped tube of strong soft cloth (Fig. 1) should be at least twice the length,

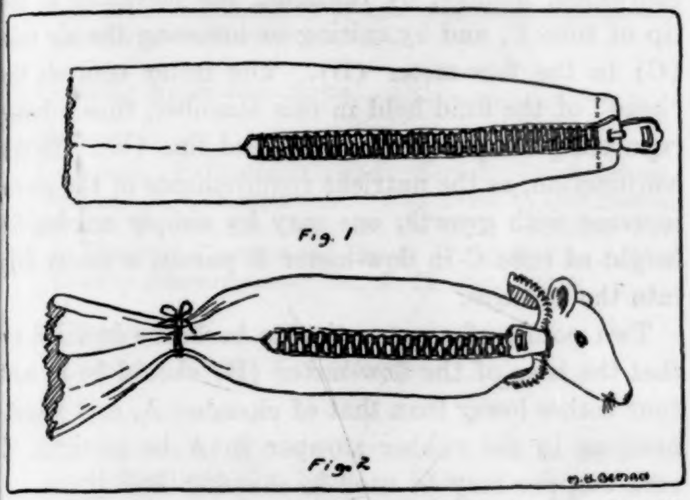


Fig. 1. The closed zipper tube somewhat shortened, with the zipper lock open at top.

Fig. 2. Animal in position in the tube ready for experiment. The zipper lock is closed.

and a third larger in diameter than the largest animal it is to hold. The basal end of the tube is left open and may be kept permanently open by reenforcing it with a ring or a hoop of the necessary size, sewed into a hem around the base. The basal third of the tube is fastened together along the side seam, and a zipper fastener with a patent lock completes the closure of the tube wall to the apex.

The animal can be caught and placed in the closed zipper tube or, by holding the open basal end of the device over the opening of the nest box, the animal may be driven directly into it. The head should be at the apex of the tube, and a reversal of this position may be prevented by tying a string around the tube directly behind the animal (Fig. 2).

To expose the head, the zipper is unlocked, pulled down as far as desired and locked. The apex of the tube wall is then folded back around the neck of the animal like a collar, thus, securely holding the individual and preventing scratching and struggling. One operator can hold the animal while the other proceeds with the marking and measuring of the teeth.

The weekly weighing of the animal is very easily and quickly done while the animal is in the tube. It can be laid on a common balance, where it remains motionless until weighed.

By variations in the kinds of cloth used, the shape and size of the tube, and other modifications, it is possible to adapt this simple device to several uses. Although we have not yet attempted to use the idea for larger animals we believe that it can be made to work satisfactorily.

It is quite advisable to use the more expensive type of zipper, for it has a locking structure that is quite useful. The zippers are attached to a heavy cloth tape and by this means they are easily sewed to the cloth of the tube.

The authors wish to express to the artist, Miss Mary K. Beman, their appreciation and thanks for the very excellent illustration of the device.

Albert R. Shadle
Irene Skarupinski
University of Buffalo

## A METHOD FOR IMBEDDING PLANT TISSUES WITHOUT DEHYDRATION

Experience has shown that many methods of dehydrating plant tissues make them so brittle that it is difficult to cut satisfactory microtome sections. Mademoiselle Larbaud and Professor Zirkle introduced an improvement when they showed that isobutyl alcohol can be used in place of absolute ethyl alcohol. Recently, Dr. L. Genevois, of the University of Bordeaux, directed my attention to the properties of methylal, $CH_2(OCH_3)_2$. Since methylal is soluble in water and lipoids, it is a good intermediate between water and oils.

The technique of passing plant tissues from the killing fluid to paraffin may be greatly simplified by the use of this solvent. The plant tissue should be washed in water, as usual, to remove the excess killing fluid. It should then be transferred through the following media into paraffin, holding it for an hour in each reagent.

(1) Methylal-water mixture 1: 1.

(2) Methylal.

(3) Methylal which has been dehydrated and neutralized by contact with anhydrous sodium carbonate.

(4) Methylal-paraffin oil mixture 1: 1.

(5) The tissues are warmed on a water bath and transferred to melted paraffin, which has a low melting point.

(6) Within an hour the plant tissues should be transferred to the grade of paraffin required for embedding.

The whole process may be carried out within three hours from the first transfer from water to methylal.

Experience has shown that the structures of the cell are remarkably well preserved. The finer details, such as mitochondria and cytoplasmic fibrillae, are not destroyed. Lignified tissues retain a soft, waxy texture and may be readily sectioned.

J. DUFRENOY

STATION DE PATHOLOGIE VEGETALE
PONT-DE-LA-MAYE, BORDEAUX (GIRONDE)
FRANCE

## AUTOMATIC FLOW-METER FOR DRIP SOLUTIONS IN PLANT NUTRITIONAL STUDIES

VARIOUS means have been utilized for providing a constant nutrient flow to plants growing in pot cultures. It has been realized that definite conclusions from such studies need to be based on several pots in each series. The drip-nutrient method, when used for several large series, necessitates a system which is simple in construction and requiring a minimum of time for refilling the nutrient reservoirs. Bearing these facts in mind, an apparatus embodying an apparently new principle of construction was devised where twelve eight-inch pot cultures were used in a single series. As a matter of fact, a larger number of pots may be used.

Fig. 1 illustrates the salient points of the system.

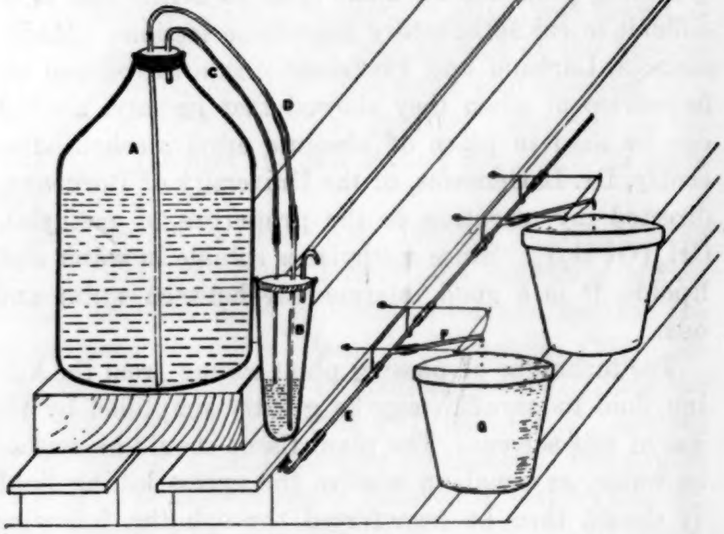

FIG. 1

The nutrient chamber (A) is a five-gallon bottle calibrated and wrapped in paper to exclude light. A narrow slit in the paper exposes the liter calibration marks. A siphon tube (D) of 12 mm bore is for delivery of the fluid into chamber B. The flow-meter (B) was constructed in order to provide a constant flow from chamber A regardless of the height of the liquid in it. Chamber B is a soil percolater of 300 cc capacity. It is provided with a 12 mm bore tube for connection with the siphon tube (D), a 4 mm bore tube for connection with the air line (C) and a small curved glass tube for the entrance of air. Experimentation showed that glass tubing of these sizes provide the most efficient operation. The air tube (C) may be of either glass or rubber tubing.

As a flow-meter, chamber B operates automatically to control the rate of flow from chamber A to the feed line (E). Explanation of the automatic action of the chamber is as follows: as the level of the liquid rises in chamber B, the flow ceases from A when the tip of the air tube (C) becomes submerged. The escape of the solution into the main feed line (E), also of 4 mm bore, permits air to enter chamber A through tube C and flow is resumed until again automatically stopped. The nutrient solution reaches the pots through capillary tube F. This tube is of 5 mm bore and is slightly bent at the tip, where it is suspended by a wire support.

The rate of drip into the pot (G) may be twice controlled, namely, by changing the elevation of the tip of tube F, and by raising or lowering the air tube (C) in the flow-meter (B). The latter controls the "head" of the fluid held in this chamber, thus directly regulating the pressure on the feed line (E). In this conjunction, as the nutrient requirements of the plants increase with growth, one may by simply raising the height of tube C in flow-meter B permit a faster drip into the cultures.

Two points of construction to be borne in mind are that the base of the flow-meter (B) should be at least four inches lower than that of chamber A, and all connections in the rubber stopper in A be airtight. A cork stopper may be used in chamber B.

This system in comparison with other drip-culture apparatus has the following advantages: no shifting of adjustments is encountered while refilling the nutrient supply chamber; it provides a uniform flow of the nutrient solution; it permits the use of double-deck benches, thus saving greenhouse space; it reduces the labor of maintenance to a minimum; it is easy to clean, and it is cheap in construction.

ROBERT E. WEAN

UNIVERSITY OF PENNSYLVANIA

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